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FEBRUARY, 1839.

Practical and Theoretical Mechanics and Chemistry.

Analysis of some of the Minerals found at Karthaus and Three Runs, on the West Branch of the Susquehanna River, Clearfield County, Pennsylvania. Accompanied by a section of the mineral ground. By Professor W. R. JOHNSON.

With a view to obtain a more exact knowledge of the resources of Pennsylvania for mechanical and manufacturing industry, than is to be procured from existing publications, or other available sources of information, the writer, in the spring, summer and autumn of 1836, made an extended tour of observation and exploration through various counties of the state, and particularly through the region bordering the West Branch of the Susquehanna River. In the course of four months spent on that stream and its numerous tributaries, he was led, among other situations, to visit the establishment at Karthaus, at the mouth of the Little Mushannon Creek, then the seat of operations of Messrs. Ritner and Loy, and since occupied by the Clearfield Coke and Iron Company, under a charter from the state. He had previously examined a specimen of the bar iron manufactured by puddling from the pig metal made at the Karthaus furnace. This specimen was found to possess a strength of 58.500 pounds to the square inch. The pig metal was gray No. 2, and had been tested at Harris' foundry at Bellefonte, where it was understood to have been found equal, for foundry purposes, to much of the iron of Centre county. At the time the metal in question was made, the ores used at the furnace were derived from two different banks, one denominated the "kidney vein," a *bed* constituting part of the regular horizontal formation in Mushannon hill, on the north side of the Susquehanna River, 344 feet above the level of the stream; the other called the "Old Barn Bank," on the Smethport turnpike, in a northerly direction from the furnace. These ores were employed in the proportion of *two* parts of the former to *one* of the latter. This bank is probably the

remains of one or more of the regular beds, and is found in the form of shell ore, or the hydrated peroxide of iron, with some earthy impurities. The ore then taken from the *kidney vein* was also, in part, in the same state, but was much mixed with the solid argillaceous carbonate, which had not undergone any change from exposure to atmospheric influences.

It may be added, that on the site now occupied by the company, a furnace for smelting iron with charcoal formerly existed, the ores for which were derived from the same banks as those first worked by Messrs. Ritner & Loy, and that with these materials good foundry iron was made.

Since the period of the visit above referred to, a considerable bed of iron ore has been discovered, about 80 feet lower in the formation than the kidney vein, or only 264 feet above the level of the river. This ore is chiefly in two *bands* of 9 and 16 inches in thickness respectively. Its position in the formation, and its regular and almost uniform character, as contrasted with that of the kidney vein, induced, it is supposed, a desire to substitute, in part, the ore of this new bed for that of the one previously relied on.

In the year 1838, therefore, the supply for the furnace was taken in equal quantities from the "kidney vein" and the "*red vein*," as this new bed has been called, and the consequence has been the production of pig metal different in character and appearance from that already described.

This circumstance induced the company to request that an examination should be made of the grounds, and trials of the ores instituted, to ascertain the value and suitableness of the several materials, for the manufacture of iron.

In compliance with this request, a visit of several days continuance was made in October, 1838, not only to Karthaus, but also to Three Runs, a point six miles lower on the river, where the company possess a tract of 1100 acres of land, lying for three miles along the northern bank of the river.

The general character of the geological formation appearing to be nearly the same in the two places, gave reason to anticipate a similarity in the minerals, and this, with such variations as are well known to belong to a large coal field, will be justified by the explorations already made.

The property here owned by the company will be found to possess a much greater quantity of ground containing the upper thick bed of coal than that which they hold on lease at Karthaus. They have also access above water level to some of the measures which at the latter place, are probably under the bed of the river. The analyses, it will be perceived, are direct, and do not profess to take cognizance of the exact relations of all the minor earthy impurities. Several trials in the humid way have however been made, tending to the same general conclusions as those herein detailed. The absolute juxtaposition of iron ore, coal, limestone, firestone and fire clay, is a significant indication of the vast importance of the district of country to which the accompanying section, made from data furnished by the company, will be found to refer.

COAL.

The bed of coal chiefly relied on for making iron at Karthaus, is the upper or main bed, six feet thick, which lies 80 feet below the surface of the summit of Mushannon hill, and 479.94 feet above the level of Susquehanna river, as represented in the accompanying section.

This coal has a specific gravity of from 1.250 to 1.278. It loses in water, during the process of distillation	0.6 per cent.
It loses in carburetted hydrogen and other volatile products	26.2
The earthy residuum, after complete incineration, is	5.05
Carbon in the coke	68.15
	100.

The coke made at the works is of medium hardness, and in all respects well adapted to the production of iron. The earthy residuum is composed of silex, alumina, and oxide of iron, with a portion of lime and a little magnesia.

IRON ORES.

Ten assays have been made on the ores found on the company's grounds, of which four were on that of the "kidney vein," at Karthaus, two on that of the "red vein," and four on the ores of different beds at Three Runs.

The "kidney vein" ore is found in different parts of a bed, marked on the accompanying section of Mushannon hill as No. 15, at an elevation of 344½ feet above the level of the Susquehanna river. It is 11 feet in thickness, composed of ferruginous and carbonaceous slate, with reniform and some stratified portions of argillaceous iron ore diffused through it, in all amounting to about 26 inches of ore. This ore bed has a stratum of coal one foot thick below, and another 3.16 feet thick immediately above it.

The ore is an argillaceous carbonate of iron, or clay iron stone of the miners.

Its specific gravity is from 3.206 to 3.397, varying with the part of the bed from which the specimen is taken.

Its colour is a bluish gray; fracture splintery, and occasionally conchoidal —the exterior of weathered specimens covered with a coat of yellowish brown hydrate of iron.

1. The first assay on a specimen having a specific gravity of 3.397, conducted in the dry way, gave—

Of water, at 320 degrees,	1.2 per cent.
Loss in carbonic acid, by calcination at a red heat,	26.68
Metallic iron,	38.33
Earthy impurities, silica, alumina, &c.	16.67

The pig metal obtained in this analysis was of a mottled gray complexion; its internal structure granular, crystalline, moderately tough, and of rather more than medium hardness; it is, however, readily acted on by the file; its specific gravity was found to be 7.726. The cinder indicated that no metallic oxide remained, or, in other words, that the maximum yield of iron had been obtained.

2. This trial was on a portion of the ore of the same bed as the preceding, but the specimen selected was a part of the shell of the carbonate, which in the outcrop assumes the character of a brown hydrate of the peroxide of iron.

Its specific gravity was 3.415.

At 320 degrees it lost, of water,	3.9 per cent.
By calcination,	6.72
The metallic iron is,	50.6
Earthy impurities,	17.1
Oxygen,	21.68
	100.

The pig metal obtained in this assay is very soft and tough; its fracture irregular; its color dark gray or mottled; structure granular, and rather less crystalline than in the preceding trial. The cinder is a transparent glass, with a slight rose-coloured tinge, indicative, perhaps, of the presence of a small quantity of oxide of manganese. The specific gravity of the pig metal was 6.24.

3. The next assay of the ore of this bed was made with a view of testing the efficacy of the limestone of Three Runs and of Karthaus respectively, as fluxes for the ore in question. The specimen now tried was without any portion of hydrate adhering to the exterior; its specific gravity was 3.206.

It lost, by calcination, water and carbonic acid,	27.42 per cent.
Assayed by 11.5 per cent. its weight of the limestone of Karthaus, it gave of metallic iron .	36.1
Earthy impurities, silica, alumina, &c. .	26.17
Oxygen . . .	10.31
	100.

The pig metal was mottled throughout, moderately hard; fracture even, and nothing of crystalline structure was perceptible. Its specific gravity was 7.102.

The cinder is a transparent glass, with a tinge of purple.

4. The same ore, treated with the limestone of Three Runs, in the proportion of 11.35 per cent., gave of metallic iron 34.54 per cent.

And the earthy matter, including some protoxide of iron contained in the cinder, amounted to .	27.34
Oxygen . . .	10.70
To which add the loss by calcination as above .	27.42
	100.

The cinder was in this case of a dirty green colour, porous, moderately fusible, and rather tough; the pig metal white, with a few specks of dark gray, producing a slightly mottled appearance.

5. This trial was on the ore from the "red vein," which is 264 feet above the level of the Susquehanna river, 11.72 feet thick, in which are two separate bands of ore. It is marked on the Section as No. 25. Specific gravity, 3.421.

This is also an argillaceous carbonate of iron, with an intermixture of some pyrites in minute grains diffused through the mass, and having its interstices coated with sulphate of lime.

This and the following assay were intended to afford another opportunity of comparing the limestone of Karthaus and that of Three Runs, as well as to make known the character of the "red vein," the discovery of which is comparatively recent.

The colour of this ore is of a bluish gray; its fracture splintery, uneven; surface harsh to the feel; the sulphate of lime in some parts crystallized in thin plates, and in others efflorescent on the surface. In drying at a temperature of 250 degrees, it loses only 0.32 per cent.

In assaying this ore with the limestone of Karthaus, the latter was employed in the proportion of 13.75 per cent. of the raw ore.

The loss by calcination—water, carbonic acid, and sulphurous acid	29.06 per cent.
Metallic iron	35.91
Earthy impurities, silex, alumina, and sulphate of lime	20.68
Oxygen and other volatile products of fusion	14.35
	100.

The cinder is black, covered with a pellicle of metal, and is difficult of fusion.

The pig metal is rather hard, brittle, and white. Its specific gravity is 6.787.

The presence of sulphate of lime had led me to suspect that of pyrites. During the calcination this became abundantly evident, by the application of suitable tests; and a careful inspection of fresh specimens subsequently detected minute crystals of sulphuret in the ore.

6. The same ore was assayed by the limestone of Three Runs in the proportion of 11.28 per cent. of the raw ore. It gave

Loss by calcination	29.06 per cent.
Metallic iron	36.07
Earthy impurities, oxide of iron, &c.	20.38
Oxygen, and other gaseous compounds resulting from the fusion	14.49
	100.

The cinder was in this case in part of a dirty yellow colour, in part dark brown, opake, tough, and easily fusible. The pig metal did not vary in any important particular from that of the preceding assay. Its specific gravity, however, was 7.272.

7. The next assay was on the compact blue clay iron stone of Three Runs, found on a bench upon the slope of the hill—its elevation not exactly determined, nor the thickness of the ore bed certainly known, but apparently of a workable magnitude.

This is a compact ore, affecting in its fracture a conchoidal form, occasionally splintery. Its specific gravity is 3.130.

Care was taken to distinguish, in this experiment, between the amount of water and that of carbonic acid. The result was

Hygrometric moisture	0.27 per cent.
Water of composition	2.09
Other loss by calcination	27.67
Metallic iron	33.81
Earthy impurities, silica, alumina, &c.	22.49
Oxygen	13.55
	99.88

The pig metal is tolerably soft, somewhat malleable, having a dark gray colour; partly crystalline structure, with a specific gravity of 7.00.

The cinder is of a dirty gray, inclining to green; porous.

8. A bank of ore has been recently discovered at Three Runs, lower in the formation than any at Karthaus, and near the level of the river. This stratum is presumed to be disclosed by the greater depth to which, at Three Runs, the river has cut its channel into the general mass of the stratification. The ore is in nodules, generally of small size, often not exceeding one or two inches in diameter. They consist, as usual, of a shell and nu-

cleus, the latter generally more or less decomposed, but sometimes found very compact at the centre.

The decomposed nucleus is often a white carbonate of iron, with an exterior rose coloured tinge; shell of a chocolate brown. The specific gravity of the shell part was found to be 3.445; that of the nucleus, 3.570.

The assay of both the shell and nucleus together gave the following results—

Hygrometric moisture	0.92	per cent.
Water and carbonic acid lost by calcination	20.60	
Metallic iron	52.42	
Earthy matter	9.32	
Oxygen	15.84	
Loss	.90	
	100.	

The pig metal obtained in this assay is of a dark gray colour, of great toughness, softness, and malleability, and would be suitable for foundry purposes. Its specific gravity is 6.540.

The cinder is a transparent glass, tinged with light pink.

9. The shell part of the above nodular ore was next treated by itself, and gave the following results, viz.

Water lost by calcination	12.70	per cent.
Iron	55.94	
Earthy impurity	8.21	
Oxygen	23.15	
	100.	

The limestone of Three Runs and the coke of Karthaus were used in making this assay, and the cinder obtained was a transparent glass of a reddish tinge, with a pellicle of metal on the exterior. It was easily fused. The pig metal is very soft and tough; its fracture uneven, with a display of occasional crystalline facets; its colour dark gray. Specific gravity, 7.01.

10. The last assay of the nodular ore was on the nucleus part, carefully freed from earthy matter, and from hydrate or peroxide. This nucleus had a specific gravity of 3.570.

It was found to contain of

Water	1.09	per cent.
Carbonic acid	30.41	
Metallic iron	38.22	
Oxygen	10.92	
Earths and trace of manganese	19.36	
	100.	

In this assay the metal was all obtained in small beads and particles—the cinder much mixed with them—and it has therefore been found necessary to estimate the last two ingredients from a knowledge of the first three items. The eighth assay being made on a specimen of ore partly composed of carbonate and partly of hydrate, gave, as might be expected, a result intermediate between those of the ninth and tenth.

LIMESTONE.

1. The limestone found in the Mushannon hill, at Karthaus, as seen at

No. 8 of the accompanying Section, 426.11 feet above the level of the river, and 3¼ feet thick, possesses a specific gravity of 2.78.

It loses, by calcination, water and carbonic acid,	36.37	per cent.
And contains of dry lime	36.08	
" protoxide of iron	6.97	
" silica	12.00	
" alumina and manganese	8.58	
	100.	

In heating strongly, to expel the last portions of carbonic acid, the lime, previously reduced to powder, became partially agglutinated together, evincing an incipient fusion.

2. The limestone found at Three Runs has a specific gravity of 2.70; is of a yellowish colour, and compact structure.

It loses, by calcination, water and carbonic acid,	32.7	per cent.
And contains of dry lime	34.5	
Silica	21.0	
Protoxide of iron	6.3	
Alumina, with a little magnesia	5.50	
	100.	

The above analyses appear to point to the cause of the peculiar character of the iron, found to be produced in one or two of the recent blasts of the company's furnace. The ore of the "red vein" contains a portion of sulphur, which the treatment of the minerals before smelting did not expel. The above analysis of the ore of the "kidney vein" did not detect the same ingredient in the contents of that bed. In the earlier blasts of the furnace, the "red vein" ore was not used, and then the iron was gray, soft, and good. The *white* metal is believed to have been chiefly, if not entirely, produced, since the "red vein" ore has been mixed with the other. It appears that the lowest yield of the ore, either at Karthaus or Three Runs, is 33.8 per cent. of pig iron, and the highest, 56 per cent., very nearly; hence, unless extraordinary imperfection exist in the running of the furnace, the quantity of raw mine required for the ton of pig metal, ought in no case to exceed three tons; and it may probably be found that two and a half tons will often suffice for this purpose, especially when a portion of the outcropping ore is mixed with the more solid parts. The nodular ore recently opened at Three Runs, whether treated with pure carbonate of lime or with the limestone of its own vicinity, yielded an iron of excellent quality, and varying in quantity from 38 to 56 per cent. of the ore employed.*

A more minute analysis of the cinder and of the residuum of the coal, to determine the best proportion of the different ores, and the quantity of flux necessary for their reduction, may hereafter be requisite, in order to the economical conduct of manufactures. Enough, however, has been shown, to indicate the intrinsic value of the materials, the fitness of several of them

* The mean yield of the ores of Wales is 33 per cent., that of those in Staffordshire, 30 per cent.—See *Voy. Metallurgique of Dufrenoy and others*, p. 100.

By the mean of sixteen analyses by Berthier, the quantity of *protoxide of iron* in the carbonates of France was found to be 39.075 per cent., which corresponds to 30.4 per cent. of metallic iron; and by the mean of eight analyses of the carbonated ores in the neighbourhood of Glasgow, by Dr. Colquhoun, the quantity of protoxide is 42.82 per cent., equivalent to 33.3 per cent. of *iron.*—*Thomp. Min.* Vol. I. p. 446-7.

for making both forge and foundry iron, and the cause of unsuitableness in others under the present mode of treatment for the like employment. Other varieties of ore than those already named, are known to exist in the neighbourhood, and have been formerly employed in the manufacture of iron at Karthaus, when good foundry metal was produced. On the whole, there is no reason to suppose that the pig iron made at these works will necessarily be less valuable than that produced in other countries, where coal and iron occur in similar juxtaposition, and where immense quantities of the best forge and foundry iron are produced.

Physical Science.

Objections to Mr. Espy's Theory of Rain, Hail, &c., in a letter to Mr. Espy, by Mr. Graham Hutchison, *of Glasgow, with replies by* James P. Espy.

Dear Sir,—Last winter, I carefully read all the papers regarding your meteorological opinions, which you transmitted me. As I did not take notes of the various statements contained in them, I now put down the following remarks merely from recollection.

According to your theory, rain, hail, snow, waterspouts, landspouts, cross-currents of air, and barometric fluctuations, are all occasioned by one and the same cause, viz. upward vortices of air, produced and maintained by the same means, viz. heat evolved during the condensation of invisible vapour into clouds. And so far as I can ascertain from the documents transmitted me, you conceive that all these meteorological phenomena are never produced in any other way. Your theory is both simple and ingenious; but I find great difficulty in conceiving how the various meteorological phenomena presented to observation in this, and in other countries, can be reconciled therewith, or explained thereby. I shall state what appear to me to be imperfections in your theory, and objections that may be urged against it, just as they suggest themselves.

1st. I find no account given in your theory how the condensation of invisible vapour into cloud, which gives out the heat that occasions the upward aerial vortex, commences. And admitting, for the sake of argument, that rain is always, and only, occasioned by an upward aerial vortex, which, according to your theory, so far as I understand it, possesses the principle of self-perpetuation, I find no explanation given of how the upward vortex, and the rain thereby occasioned, should ever cease, when once it has commenced. Let us consider these two points separately.

Rain never begins to descend till the clouds have acquired a considerable degree of density. But your theory gives no account of how invisible vapour begins originally to condense into visible vapour, or cloud. If you say that condensation of invisible vapour begins in consequence of an upward vortex of air, the query then is, what originates this upward vortex of air?* According to my notions on the subject, the formation of clouds is chiefly occasioned by whatever reduces the temperature of the atmosphere; and this may be produced in a variety of ways, such as, 1st, By the reduction in the temperature which takes place during the transitions from day to night, and from summer to winter.† 2d, By the transportation of air by

* The up-moving column of air may take its rise either from acquiring more heat or more vapour than surrounding portions of the atmosphere; for it is known that vapour is only five-eighths the specific gravity of air.

† This cannot be the cause—for we have in this climate at all seasons numerous instances of entirely clear nights succeeding days with many clouds. No phenome-

15	Ore Ground, containing 26 Inches Kidney Ore		11 . 00		
16	Little Vein of COAL		1 . 00		344 . 47
					343 47
17	Brown Rock		20 . 75		
18. 19. 20	5½ Feet COAL Vein	Coal	1 . 00		322 . 74
		Slate	0 . 25		321 . 74
		Coal	3 . 50		318 . 99
21	Fire Clay		2 . 50		316 . 49
22	Brown Rock		35 . 28		
23	1½ Feet COAL Vein		1 . 50		281 . 21
24	Fire Clay, mixed with Iron Ore		3 . 00		279 . 71
					276 . 71
25	Red Vein, Iron Ore Formation, cont^{s} 25 Inch^{s} Ore		11 . 72		
26	Slate				264 . 99
27	Ore Formation & Clay or Shale		5 . 00		259 . 99
28	Slate		3 . 50		256 . 49
29	IRON or (Clyde)		6 . 00		
30	Iron Ore Formation	Mine ground	83		250 . 49
31	Black Slate		2 . 50		249 . 66
32	COAL		6 . 00		247 . 16
			1 . 33		241 . 16
	8 Veins	*Total of Coal Proved 20 Feet 32*			239 . 83
33	Unproved Strata		239 . 83		

P.S. Duval Lith Phila

17	Brown Rock		20 . 75	17	
18. 19. 20	3½ Feet COAL Vein	Coal	1 . 00	18	322 . 74
		Slate	0 . 25		321 . 74
		Coal	2 . 50		318 . 99
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SECTION of MUSHANNON HILL near KARTHAUS.

No.	NATURE OF MATERIALS.	Thickness Feet dec.	Elevation above the Susquehanna
			564. 94
1	Top or highest Covering	78. 00	
2	Slate	1. 00	486. 94
3	Six Feet COAL Vein	6. 00	485. 94
			497. 94
4	Fire Clay	2. 50	477. 44
5	Brown Sand Rock	45. 00	
6	Coal	0. 83	432. 44
7	Fire-Stone	2. 00	431. 61
8	Lime-Stone	3. 50	429. 61
9	Ore ground, containing Balls	1. 00	426. 11
			425. 11
10	Brown Sand Rock	24. 78	
11	Three Feet COAL Vein	3. 00	400. 33
12	Slate	1. 50	397. 33
			395. 83
13	Grey Sand Rock	37. 20	
14	Three Feet COAL Vein	3. 16	358. 63
			355 47
15	Ore Ground, containing 26 Inches Kidney Ore	11. 00	
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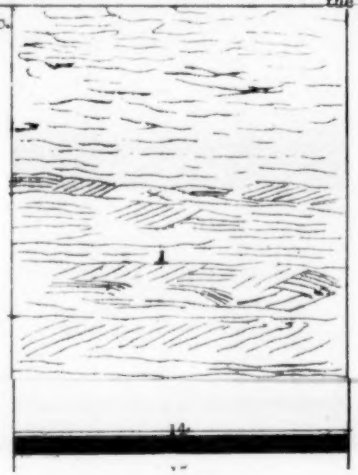
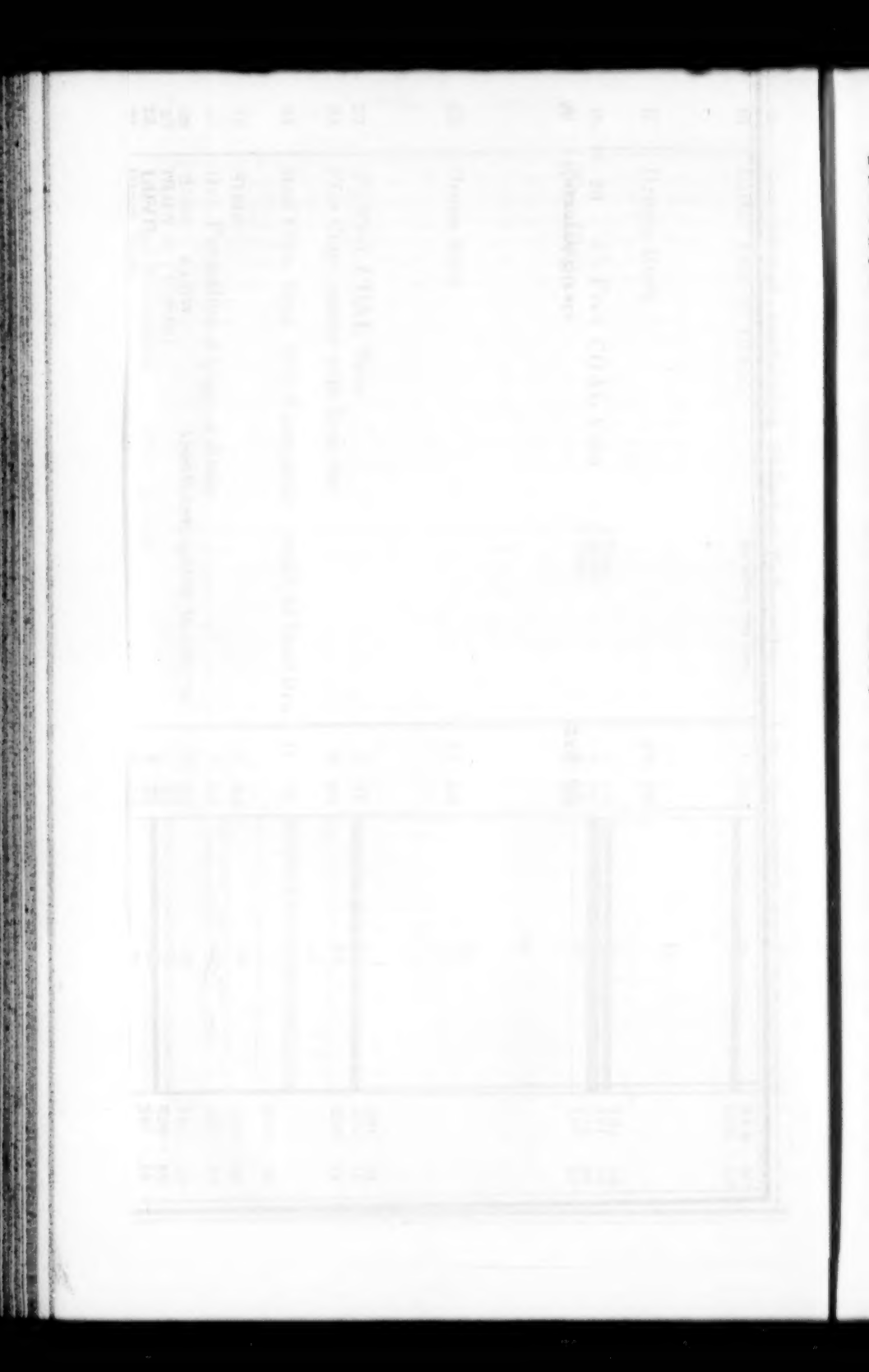
SECTION OF MUSHANNON HILL NEAR KARTHAUS.

Journ. Franklin Institute. Vol. XXIII. Plate II.

Nº	NATURE OF MATERIALS.	Thickness Feet	dec.	Elevation above the Susquehanna	
				564.	94
1	Top or highest Covering	78.	00		
14	Three Feet COAL Vein	3.	16	358.	63
				355	47





means of aerial currents, from a warm towards a comparatively cold latitude or locality.* 3d, By the elevation of atmospheric currents in surmounting hills and elevated lands.† And also, as I hypothetically conceive, (though I am very doubtful of the truth of this hypothesis,) by the slow ascension of the atmosphere in the warmest latitudes of the earth, during the rainy season, in order to supply upper currents then diverging from these latitudes towards the north and south.

These causes are assisted, 1st, By the gradual intermixture of different strata of air when the upper strata become colder and specifically heavier than those underneath, after making the necessary allowance for the reduction of temperature, and diminution in the specific gravity of the aerial strata, which results on ascending from the diminishing incumbent pressure.‡ And it does not matter, whether the superior warmth of the inferior strata be occasioned by clouds arresting the radiant heat passing downwards towards the surface of the ground during day, or passing upwards from that surface during night; or whether it be occasioned by the evolution of heat which attends the condensation of invisible vapour into clouds during the

non is more common than for clouds to begin to appear at 8 or 9, A. M., and increase till the hottest part of the day, and then gradually disappear after sunset. And in Jamaica, this occurs every day in the dry seasons, almost always producing rain in the interior of the island about one or two o'clock.

* If cloud is produced in the first way, it ought to be in contact with the ground. For it can only be chilled by contact. This undoubtedly sometimes occurs, and fog is the result. But I have constantly observed, that when a very warm, and even damp atmosphere begins to blow from the south, after a very cold spell of weather, when the ground and stones of our pavement are so cold as to condense upon them a portion of vapour from the air—none of those clouds called cumuli are ever formed—the reason I suppose to be that no up-moving columns can then be formed.

Neither is cloud formed by the change from summer to winter, for there is more rain in the spring than in the autumn.

† This is undoubtedly one cause of clouds; but unless the cloud is specifically lighter than the surrounding air, how are these currents surmounting hills produced?

‡ If cold air comes down from a height sufficient to double its density at the surface of the earth, its temperature would be increased about 90 degrees, and it would be capable of containing about eight times as much vapour as it contained before it commenced its descent, even if it had been saturated; and the more it mingled with air in descending, the dryer it would make it—all which is known by experiment. And if heated air goes up, it is also known by experiment that it will condense more than one-half its vapour by the cold due to diminished pressure, before it reaches sixty hundred yards high; and that too without mingling with the air on the outside of the ascending column. It is also known by experiment that the vapour thus condensed, if the dew point is at 70° Fahr., (about a mean in our summer at Philadelphia) would give out as much caloric of elasticity into the air, where the cloud was formed, as would be given out by burning upwards of twenty thousand tons of anthracite coal on each square mile over which the cloud extends. And this would expand the air between five and six thousand cubic feet for every cubic foot of water generated in the cloud, after making the allowance for the diminished volume due to the condensation of the vapour itself. There fell in twenty-two hours at Ardeche, in France, thirty-one inches of rain, and it may easily be calculated that the caloric of elasticity given out during this time was sufficient to heat the whole atmosphere over the region where the rain fell to the above depth, 280° Fahr., provided no allowance is made for increased specific caloric of the air at great heights. The explanation of this astonishing phenomenon is too plain, according to my doctrine, to need any elucidation, except the simple statement that a cold of about 90° is generated in every portion of air which rises high enough to become of half the density which it had at the surface of the earth.

transportation of air from a warm to a comparatively cold locality, or any other cause.

The causes before mentioned are also assisted, 2d, By the more rapid diminution of the elasticity of aqueous vapour than that of air, as the temperature of both is reduced in ascending perpendicularly. This is unquestionably the chief cause of clouds forming at a considerable altitude in the atmosphere, rather than nearer the level of the sea. Indeed when the ocean to the north is warmer during the depth of winter than the incumbent atmosphere, and much warmer than the land, evaporation may, and frequently does, go on from the ocean to such an extent as to produce long continued rainy and cloudy weather, when the wind blows from a northerly and cold direction. Our snow storms from the north-east or north-west, and I apprehend your snow storms from the north-east, during the coldest season of the year, are produced in this manner. The moisture evaporated from the then warm surface of the ocean is condensed into clouds as it rises in the cold atmosphere. And this condensation is promoted by the farther reduction of temperature which it undergoes, in being transported over the cold winter surface of the land by aerial currents. In the climate in which I reside, the principal cause of the formation of clouds undoubtedly is, the transportation of air from a warm towards a comparatively cold locality by means of aerial currents. But whatever causes clouds to begin to form, if continued, must increase their density until rain is produced.

Again, if clouds and rain be produced only by an upward vortex of air, (supplied by converging currents below the clouds, and disposed of by diverging currents above them) which, according to your theory, has the power of perpetuating itself; when once begun, it should become a sort of perpetual motion, that could not by any possibility come to an end. But instead of this being the case, we find that all rains terminate.*

2d, If you state that upward vortices must be occasioned during day, by the atmosphere nearest the surface of the ground becoming then much more heated than the aerial strata above, the following and similar objections present themselves: 1st. How does more rain fall during night than during day? 2d. How does it never rain in Egypt, where the wind blows almost incessantly from the north, that is, from a cold towards a comparatively warm climate, and from the sea towards the land? According to your theory, the cold saturated air from the Mediterranean should have an unusual tendency to rise in vortices as it became heated in passing over the heated sands of Egypt; and contrary to what is the fact, should there produce in-

* When a lofty cloud is once formed, it certainly has a self-continuing power; and accordingly, we find that many storms originating in the West Indies, have continued for many days and nights in succession, and traveled many thousand miles from the place of beginning; terminating, it is true, in one place, but continuing to rage with violence in another. But to infer that they could not, by any possibility, come to an end, if they are really generated in this way, is illogical; for there may be many causes tending to diminish and finally destroy their force.

The quantity of rain which comes down from a great height has a tendency, both by impulse and its cooling effect on the air below, to diminish and sometimes stop its upward motion, and in the case of the rains in Jamaica, in the middle of the day, they appear to invert the motion and produce a land breeze towards evening. And when the land breeze commences, the air over the middle of the island must come downwards, and then not only will the rain cease, but the cloud which was formed by the upward motion will disappear, as it comes under greater pressure—as is demonstrated by experiment. Other means of terminating storms will be explained in a subsequent paper on the Moray floods.

cessant rain.* 3d. In like manner, how does it happen that at Marseilles, during the depth of winter, when the wind shifts from the north, and begins to blow from the south, that is, blows from the Mediterranean, and from a warm towards a comparatively cold land surface, clouds should rapidly begin to form and increase in density till rain begins to fall. The surface of the land being then so much colder than the incumbent atmosphere brought by a southerly wind from the Mediterranean, cannot give rise to an upward vortex upon any principle that I can conceive; but on the contrary, by communicating its coldness to the incumbent atmosphere, and thereby increasing its specific gravity, should rather counteract any tendency to an upward vortex of air.† In like manner, in the United States of

* This objection seems to be founded on an illogical deduction from my doctrine, that because all rains and snows and hails are produced by an up-moving current of air, therefore all up-moving currents of air must produce rains, hails, or snows. This does not follow: for if any one will take the trouble to look how cumuli are formed in a summer day, he will see them sometimes swelling up to a great height, and then, not yet having got dense enough to rain, their tops will be swept off by an upper current, moving in a different direction from themselves, or with a different velocity; and they will thus become spread out along the heavens, and their up-moving power destroyed. Now when the north wind blows in Egypt, the current below is almost diametrically opposite to what is known to be the direction of the current above in that latitude.

Besides, the current above contains all the caloric of elasticity which was given out to it, during the great condensation of the vapour which produces the mighty rains as it passes over the mountains in Abyssinia: so that it will contain very much more caloric to the pound than even the hot air on the surface of the ground in Egypt; and therefore when the up-moving currents over that country rise to the height of this upper current which is flowing off towards the north, they will enter a medium of less specific gravity than themselves, and on that account they will cease to rise.

Besides, I have long observed that if the dew point is more than 20° below the temperature of the air, cumuli hardly form, though the day is entirely clear, and up-moving columns forming as usual. This circumstance is easily understood, when it is known, as it is by experiment, that these columns cool about one degree and a third for every hundred yards that they ascend, whilst the strata of the atmosphere itself are only one degree colder for every hundred yards high. From these two facts it follows, that though the columns start upwards by their specific levity from greater heat near the ground, they are constantly, in their ascent, approximating nearer and nearer to a state of equilibrium with the surrounding air at their own elevation, and finally must cease to rise, unless they reach the point where cloud begins to form, and then as the law of cooling is changed to about two degrees for three hundred yards, the upward motion will be continued, unless hindered by some of the causes mentioned above.

† The effect here, I think, is put for the cause, and if so, the whole difficulty vanishes. The blowing of the south wind at Marseilles is not the cause of the formation of cloud, but the formation of cloud is the cause of the south wind. Now this south wind will bring with it a high dew point, and of course a light air, well calculated to run in under the base of a cloud already formed, and from the high *steam power* which it contains, calculated to increase its power of upward motion.

It is asserted that clouds begin to form after the south wind begins to blow: but if it should be discovered hereafter that the clouds begin to form first, the whole phenomenon is explained, and another strong link is added to the chain of evidence which is already formed in favour of the *law of storms* for which I contend. Now I have known many instances of long continued rains in the north, while there was a constant south wind, or rather west of south, in consequence of oblique forces operating generally to produce that effect in this latitude; and I never yet heard of a great rain in the western part of New York, without a southern wind at Philadelphia. And it will be very readily seen, that any air, however cold, if it is near the borders of a lofty cloud, will run in under that cloud, and be forced to ascend, when it comes under, if

America, where you reside, when the wind, during the depth of winter, blows from an easterly direction, that is, from the Atlantic, and a then warmer climate, clouds begin rapidly to form and rain follows, in consequence of the reduction of temperature which the comparatively warm atmosphere from the Atlantic undergoes in being transported over the then cold surface of the land.* But no upward vortices of air could be thereby generated, so as to account for the formation of clouds and rain agreeably to your theory. On the contrary, during the depth of winter, from Christmas till the end of February, when the prevalent wind in the United States is from the west or north-west, that is, from a cold towards a comparatively warm climate, upward vortices of air, and clouds, and rain, agreeably to your theory, ought to be produced; whereas, clear, dry, frosty weather is then the invariable concomitant of such a wind. Similar observations are applicable to the climate in which I reside, and in all others in temperate and cold latitudes. The most rainy winds are those which blow from a warm towards a comparatively cold climate; and the driest winds are those which blow from a cold towards a comparatively warm climate. But the former, viz. the rainy winds, can never originate an ascension of the undermost atmospheric strata; whereas, the latter, upon the principle of monsoons, and sea and land breezes, must always produce that tendency in a greater or less degree.

3d. In certain great rains, mentioned in your reports, extending simultaneously over a surface of many hundred miles in diameter, the wind at the surface of the earth, over the whole extensive tract of country where the rain fell, is said to have been blowing with great, or considerable, force, towards the centre of where the rain was falling; that there it fell in greatest quantity; and there, and there only, so far as I understood your report, the upward vortex of air existed. Now I am at a loss to know how any rain should have fallen, agreeably to your theory, beyond the boundaries of your supposed upward vortex of air. If clouds and rain are produced only by an upward vortex of air, how did it happen, on these occasions, to rain simultaneously for several hundred miles east, west, north and south, of the supposed upward vortex?†

a cloud has indeed the specific gravity which I assign to it: so that although a warm south wind blowing over a cold surface of land may be unsuited to originate an upward motion of air, yet it is well calculated to continue that upward motion after it has originated.

* The whole doctrine of our north-east storms appears to be entirely misunderstood. During their entire progress from the West Indies, in which they frequently originate, to Maine, the wind does not blow from a warmer to a colder climate, but the reverse. When the storm is yet in the West Indies, the wind is blowing from the N.; and when it reaches South Carolina, the wind in North Carolina and Virginia is from the N. E., and when it reaches Virginia, it is blowing in Pennsylvania and New York and Massachusetts from the N. E., and in Ohio from the N. W.; and in the northern borders of the storm, the wind is most violent from the north, and the quantity of snow is the greatest, as far as ascertained. See Jour. Frank. Inst. for Sept. 1837.) Moreover, whenever these storms pass Philadelphia, and are raging in the north-eastern states, the wind invariably changes to some western point, sometimes to the north of west, and sometimes to the south of west. It is true, that on the southern borders of these storms, the wind, at the same time, is blowing from some southern direction, and no doubt contributes much to the violence of the storm, from the quantity of steam it brings to the focus of action.

† Here again the doctrine taught by me appears to have been entirely misunderstood or overlooked.

The doctrine I have taught in all my essays is, that as soon as the air around a

4th. If your theory supposes that an upward vortex of air exists over the whole extent of surface where clouds are forming, or rain falling, the clouds, when viewed from the surface of the ground underneath, should always be stationary, though the wind be blowing underneath with great velocity, and in one determinate direction. Now in this country, (and I suppose it must also be the case in America,) when the wind blows with great or considerable velocity in one determinate direction, and clouds are forming or rain falling, the clouds are always moving in the same direction, and as nearly as can be estimated, with the same velocity as the air near the surface of the ground. Indeed, I have never, in a single instance, observed clouds remaining stationary during a very heavy rain, when the wind underneath was blowing strongly. Besides, the edges of clouds are frequently of such a ragged and marked character, and retain the same distinctive configuration for such a length of time, that if there was any rapid upward vortex of air underneath, such as is stated to be the case in your reports, the upward movement of the edges of the cloud would have been long since observed, and universally admitted; whereas, though horizontal movements of clouds during rain are constantly observed when there is any wind, an upward movement from underneath never has been noticed, and is not visible, so far as I am aware.*

5th. If I recollect right, you mention in one of your reports, that the heat communicated to the incumbent atmosphere by some very limited combustion underneath, gave rise to an upward aerial vortex which occasioned a local thunderstorm accompanied with heavy rain. I am inclined to think that if such a limited cause of increased aerial temperature produced the

cloud comes in under its base, it is under less pressure, and begins to ascend, not, of course, perpendicularly, but obliquely. It is only in the centre where the motion can be perpendicular; and so far from the greatest quantity of rain falling always in the centre of the storm, it sometimes happens that the perpendicular velocity of the air is so great, that the drops of rain are not permitted to fall there, but are carried up to a great height, and then spread outwards towards the borders of the storm, and fall there where the upward motion is not sufficient to overcome gravity. And if they should be carried high enough to freeze, they will fall in *hail*.

* In our great north-east storms, when they approach Philadelphia from the south-west within three or four hundred miles, the wind begins to blow from the N. E., and at the same time the top of the cloud from the storm generally makes its appearance, coming from the S. W.; and those two currents in opposite directions, continue for several hours before many clouds form below—and even when they do begin to form below, by the gradual sloping of the air upwards, the upper clouds are still seen through the openings, coming and thickening from the S. W.

It is true, indeed, when the storm of rain or snow comes on, the upper clouds are concealed entirely from view, and the lower clouds, being in the under current, are seen moving in the same direction with the wind.

Moreover, in violent summer thunder showers, which are sometimes only ten or twelve miles wide, I have frequently seen the clouds in the lower part move with great rapidity towards the centre of the cloud from all sides, and before I knew of the upward motion of the air in the middle, I have stood looking on with amazement, at not seeing them overlap, but seem to lose themselves in the centre, and others succeed in their turn. But when I calculated the effect produced by the evolution of the caloric of elasticity which is given out during the formation of cloud, and found that the volume of air in which the cloud was formed would be increased about six times as much by receiving this caloric, as it would be diminished by the condensation of the vapour into water, the mystery was immediately explained. And I think the reader will find, that this single principle will leave but few mysteries in meteorology, except the luminous meteors, unexplained.

thunderstorm in the case referred to, there would be an almost constant upward aerial vortex, accompanied with thunder and rain, over every large city. London, including its suburbs, extends about twelve miles in length by eight in breadth, and contains a population of about 1,800,000. In calm weather, particularly during winter, the increase of temperature communicated to the atmosphere by the combustion of fuel and animal respiration over the central portions of such a large city, cannot be less than eight or ten degrees beyond that of the atmosphere in the surrounding country. But instead of an excess of rain falling over London, the annual amount of rain there is only 22.2 inches, which is less than in almost any other part of England, where observations have been made. The air in the central parts of Glasgow during calm weather, in winter, is usually six or eight degrees warmer than in the surrounding country. Now, if this excess of atmospheric temperature occasioned an upward aerial vortex so as to produce clouds and rain, as should be the case if your theory were correct, the amount of rain that falls at Glasgow should be unusually great. But instead of this being the case, the annual amount of rain collected in the rain gauge kept at the M'Farlane Observatory, College Garden, when averaged for upwards of thirty years, was only about 22 inches; whereas the annual amount of rain collected in every one of the rain gauges kept within a limited number of miles of the city, was considerably greater. The circumstance of the amount of rain collected in the rain gauge kept at the M'Farlane Observatory being so much smaller every year than what was collected in any other rain gauge in the surrounding neighbourhood, attracted so much attention, that a committee of skilful mechanics and mathematicians were appointed to examine it. And they, after minute examination, reported that its construction and condition was in every respect accurate and perfect.*

6th. In one passage of the documents sent me, clouds, so far as I recollect, are stated to have been observed eleven miles high; and in another passage, fourteen miles high. No observations ever made in Europe, that I am aware of, have afforded evidence that clouds, even of the cirous kind, exist in the atmosphere above the elevation of 25,000, or 30,000 feet, at most.

* I do not recollect that I ever said, in any of my writings, that the heat communicated to the incumbent atmosphere by a very limited combustion, occasioned, by the upward motion produced in the air, a local thunderstorm, accompanied with heavy rain. But as it is my belief that great fires under favourable circumstances, may produce rains, I may have said something like it. But as this is a mere matter of opinion, and as it can only be decided by experiment, which I hope soon to try, I forbear to dwell on this point. I am, however, grossly misinformed if it does not rain much more frequently in and about large manufacturing cities in Europe, especially in Great Britain, than in other parts. It does not follow however, from this, that there will be more rain in the city itself than in the suburbs or the adjacent country; for the air is seldom so still that the column of cloud which might be formed over the city by the up-moving column of air, would remain so perpendicularly over the place of its formation, as to rain down on the city itself, as much as it will in the suburbs and neighbouring regions; and as the wind prevails from the west in the British isles, it is likely that more rain would fall on the east side of these great manufacturing towns than on the west. In accordance with this theoretical deduction, my friend, Mr. T. Sully, on his return from Europe, told me, that in comparing notes with Mr. Leslie, he found that Mr. Leslie had many more favourable days for painting in the west part of London, than Mr. Sully had, who was more eastern, on account of the thick weather and misty rain, which prevailed more where Mr. Sully lived. (More observations on this point are much wanted.)

7th. According to your theory, barometric fluctuations are occasioned exclusively by the same cause that produces clouds and rain, and which you say is an upward vortex of air, produced and maintained by heat evolved during the condensation of invisible vapour into clouds. Now when it is considered that the amount of rain which falls in a given time, and the amount of heat evolved during its conversion from invisible vapour into clouds, decreases from the equator to the poles, your hypothesis cannot be reconciled with the fact, that the range and fluctuations of the barometer, instead of decreasing, (as would be the case if your hypothesis were correct,) rapidly increases from the equator to about the 60th parallel of latitude, and again decreases from the 60th parallel as we advance towards higher latitudes. That this is the case, is evident from the following table:*

		Mean annual range of the barometer.
Quito,	S. lat. 0° 13	about 1 line.
Peru,		$\frac{1}{4}$ of an inch.
Calcutta,	N. lat. 22° 35	$\frac{1}{2}$ an inch.
Kathmander,	lat. 27° 30	.85 an inch.
Capital of Japan,	lat. 32° 43	.85 an inch.
Paris,	lat. 48° 50	$1\frac{1}{4}$ inches.
Great Britain, averaged		2 inches.
Petersburg,	lat. 59° 56	$2\frac{1}{4}$ inches.
Melville Island,	lat. 74° 30	1.86 do.

* According to my theory, undoubtedly the great barometric fluctuations are produced solely by the caloric of elasticity evolved by the condensation of vapour in storms.

I have made the calculation how much the barometer ought to fall under a cloud of a given height, with a given dew point, that is, with a given steam power in the air, and as this calculation is made on acknowledged scientific principles, it must stand, unless the principles themselves fall. The objections leave this fundamental principle unimpeached. No notice has been taken of it.

It is true indeed, that my "doctrine cannot be reconciled with the fact, that the range of the barometric fluctuations rapidly increases from the equator to about the 60th parallel of latitude." And if this were really a fact, it would be fatal to my doctrine, so far as the barometer is concerned, and then I would have to abandon the whole ground. But the fact is not so. If the reader will turn to Col. Reid's late work on hurricanes, he will find, at page 59, that the barometer fell at Porto Rico to 28 inches, on the passage of a hurricane, and rose 1.17 inches in an hour and a half. (See January number of this Journal.) And at page 269, the barometer fell in the Bay of Bengal, in a tremendous hurricane, to 27.80—having stood at 29.70 at the beginning of the storm. And at page 271, the mercury sunk out of sight below 26.50, having stood three hours before above 29 inches. This was at the mouth of the Hoogly—while at Calcutta, about one hundred miles off, the barometer fell only three-quarters of an inch.

Now, as these great fluctuations occur in these latitudes only when a great hurricane occurs, and are known to accompany the hurricane in its progress, and are great in proportion to the violence of the storm, it seems almost certain that the cause of the storm is the cause of the fluctuation, unless they are related to each other, as cause and effect.

Indeed, if it is a fact (and nothing is better established) that the barometer does stand low in the middle of these great hurricanes, all the other phenomena connected with them are mere corollaries. The wind will blow inwards with a velocity proportionate to the square root of the depression of the barometer; it will rise in the central parts of the storm in a similar ratio, that is, with the velocity of about 240 feet per second for a depression of one inch, without making any allowance for the rise of the barometer in an annulus all round the storm, in consequence of the rapid efflux of air on all sides in the upper part of the cloud; and even the very quantity of vapour con-

There is no doubt that such a thing as upward vortices of air, and gradual ascensions of large tracts of atmosphere supplied from underneath, by aerial currents near the surface of the ground, are constantly and simultaneously occurring on an immense number of different parts of the earth's surface. Whirlwinds afford examples of upward vortices of small extent. Sea and land breezes, monsoons, and local as well as more extended winds, blowing from a cold towards a comparatively warm climate or locality, can only be accounted for by supposing that opposite aerial currents simultaneously exist in the upper and lower halves of the atmosphere. The air, in such circumstances, must be gradually descending over the cold locality to supply the lower current; and ascending over the warm locality, to supply the upper current. But some of the facts which I have mentioned, such as the case of the north wind in Egypt, sea and land breezes in intertropical climates during the dry season, and the general fact of all winds that blow from a cold towards a warmer locality, being comparatively dry winds, show that the upward ascension of air is not the only cause of rain.* And judging from the facts mentioned, and others of a similar kind, I am very doubtful if an upward vortex of air, either upon a limited or an extend-

densed per second may be calculated, if the dew point and depression of the barometer are given; and it is found adequate to produce those mighty floods of rain which are known to fall in these storms. The quantity of rain which sometimes falls in one of these hurricanes, over a limited space, is certainly as much as ten inches; in which sufficient caloric of elasticity is given out to heat the whole of the air over this region, from the top of the cloud down to the surface of the earth, more than one hundred degrees. But when it is considered that every portion of air which rises from the surface of the earth to that height, undergoes a refrigerating process of more than one hundred degrees, from diminished pressure, and that it would actually become colder to that amount, if it were not for the caloric of elasticity given out in the condensation of the vapour, which prevents it from cooling more than about half this quantity, as I have demonstrated by experiment, it will no longer be a mystery how so great a quantity of vapour is condensed by cold, in air which is at the same moment receiving such an immense amount of caloric.

* This conclusion does not follow from the premises. It would be logical to say, these facts show that the upward motion of air is not always the cause of rain; and such is undoubtedly the fact. I have myself seen hundreds of up-moving columns forming large cumuli without producing rain, but it certainly does not follow from that fact, that cumuli are ever formed without up-moving columns.

Flat low islands in the West Indies have sea breezes, and of course up-moving columns in the central parts of them, but there being no mountains to prevent these columns from being swept off, out of the perpendicular, before they rise high enough to form dense and deep clouds, rain is frequently not the result. Now when the wind blows from the north-west at Philadelphia, though up-moving columns may be formed in great numbers, as they no doubt are, yet they do not rise very high till they enter a current above, moving in a different direction, and though clouds may begin to be formed before they enter that current, yet when they do enter it, the columns will be broken and their force destroyed.

On the contrary, whenever the lower current of the air is moving in the same direction with the upper, and with the same velocity, which can only be the case in this latitude, when the wind is from some southern or south-western direction, then the columns can rise to a great height without being broken, and this is one reason why a southerly wind is favourable for rain. These observations apply exclusively to the generation of a rain cloud, and not to the phenomena which occur after a great rain cloud is generated. After that is done, the cloud has a self-sustaining power, and frequently continues as violent in the night as in the day, and if even it should be found to discharge more rain in the night than in the day, as asserted above, it would not be inconsistent with my theory.

ed scale, (except upon the principle of intermixture,* and also when the atmospheric current rises in surmounting hills,) is ever, in any instance, a cause of the formation of clouds, or of the descent of rain, *in temperate or cold latitudes.* And from comparing the extreme smallness of the fluctua-

* The doctrine of the intermixture of airs at different temperatures producing rains will not bear the test of examination. I demonstrated, in the very essays here criticised, as the reader will see in the Journal of the Franklin Institute for 1836, that if the two halves of the atmosphere, the upper and lower, one at the temperature of 80° and the other zero, both saturated with vapour, should be mingled together by magic, (for they cannot be mingled by any causes in nature) that the caloric of elasticity given out in one of our great thunder storms, (5.1 inches of rain) if communicated to the mass of air so mingled, would leave the whole about 20° hotter than the hottest half before the mixture. But why suppose a mixture in case of an upward motion of air, as it is here supposed, if it goes up to where the barometer would stand 15 inches, it would cool without mixture at least 85°, as I have demonstrated by experiment, if no allowance is made for the caloric of elasticity given out by the condensing vapour.

And if any one will carefully watch a cumulus cloud while forming into a nimbus, if he is properly situated for seeing the whole phenomena, he will observe a wonderful stillness in the borders of the cloud, while it is puffing out at the top, as if it were "blown into below by a pair of great bellows."

He will see the lower part of the cloud much agitated, and flocculi darting in from the borders towards the centre, and finally, small clumps of clouds suddenly forming some distance below the black base, and darting up into that base, "like sky rockets;" in short, the whole phenomena corresponding precisely with the supposition of an upward motion of the air, both below and above the base of the cloud. If this cloud is formed from the mixture of airs of different temperature, which I have shown could not be on other grounds, I think it is certain that it could not assume the present form. If it were formed of strata of air, one over the other, and moving in different directions, so as to mingle between them and produce cloud, then the cloud would have a flat appearance, and could not possibly rise into a pyramid of six or eight miles in height, in a very short space of time, in regular form.

If it was formed either by an up-moving column of warm air, or by a down-moving column of cold air, mingling with the air through which it passed, then would the cloud appear something in the form of a hollow cylinder, for the central parts of the ascending or descending column could not mingle with the surrounding air. Now the central parts of the cloud seem to be much the densest, if we can form any judgment from the blackness of the base, just as it should be on my principle, but not at all on the Huttonian. It will not surely be contended that air can be mingled to any extent sufficient to produce large clouds by different currents meeting each other on the same horizontal level, and even if it should, it could not be imagined how a cloud in the shape of a sugar loaf could be formed on this principle, with a flat base, always just about as many hundred yards high as the temperature of the air is above the dew point in degrees of Fahr. at the time the cloud is forming, which exactly corresponds with the height of the base, on the supposition that the air does move up from the surface of the earth into the base of the cloud. Besides, if it should be found, as is highly probable, that the upper portions of the atmosphere always contain more caloric to the pound than the lower, from the caloric given out there by the vapour condensing into cloud, the doctrine of mixture forming cloud, would have to be given up on this ground alone.

I have now attempted to answer all the objections which have been brought against my theory by a gentleman of highly cultivated and acute mind, one who has himself written one of the best treatises on meteorology extant, and also a very late work on Unexplained Phenomena, which I do not hesitate to say, manifests great originality and power of thought, though I am not yet prepared to subscribe to all his views.

If I have not been entirely successful in answering, to the satisfaction of the candid reader, all the objections, I think it will be but fair to set down the failure, not to the weakness of the theory, but to the want of skill in the advocate. Indeed I doubt not that the intelligent reader who has made himself thoroughly acquainted

tions and range of the barometer in intertropical climates, where the rains are heaviest, with its great fluctuations and range in temperate latitudes, where the amount of rain is comparatively very small, it is obvious, that if clouds and rain be occasioned by upward vortices of air, barometric fluctuations must be either wholly occasioned, or at all events much assisted, by some other cause.

The preceding remarks are penned in a spirit of perfect candour and impartiality, and I hope you will receive them in a similar spirit. They will point out the objections to your theory which most readily suggest themselves to the mind of an impartial reader. If your theory be true, you will be thereby enabled to know what points require further elucidation, and also what objections ought to have been anticipated and answered —an object, which, in advancing a new theory that has to contend with pre-existing opinions, ought never to be lost sight of.

I am, dear sir, your most ob't. servant,

GRAHAM HUTCHISON.

Glasgow, Scotland, 11th October, 1838.

with the theory, will see that many points could be much more clearly elucidated. If, indeed, I had not been able to answer any one of the objections, the theory might still be true, for the foundation of it is not shaken by any one of them.

Suppose, for instance, I had not been able to show that the barometer does actually fall in the torrid zone, on the passage of a hurricane, it would not prove my theory untrue, because it might have so happened that no barometrical observations had ever been recorded in the midst of the storm. If, indeed, it had been established by well authenticated observations that the barometer does not fall in the middle of a hurricane, I would have to acknowledge it to be the *experimentum crucis* to disprove my theory. But this fact never will be established. For so long as the laws of gravity remain unchanged, the barometer will fall when pressed by less incumbent weight, and as long as the relation between the caloric of elasticity of vapour and the specific caloric of atmospheric air, remains unchanged, this caloric will expand the air in contact with the condensing vapour, in the formation of cloud, upwards of five thousand cubic feet for every cubic foot of water thus generated, after making allowance for the condensation of the vapour itself—as I have demonstrated by experiment, independent of the chemical principles on which the calculation was originally made. (See Phil. Saturday Courier, of 18th March, 1837.)

I thank the author of these able strictures for the candid manner in which they were made. If my theory is true, it will bear the test of the severest examination, which I invoke from other minds of equal acuteness. If it is false, no one is more interested than myself that it should be speedily refuted. But in this inquiring age, when men will think for themselves, neither the hasty and unpremeditated opinion of one of the most distinguished philosophers of Europe, that Mr. Espy's theory could not be true, for it requires the barometer to stand high in the middle of hurricanes, nor the deliberate and long cherished opinion of a distinguished chemist of America, of whose discoveries his country is justly proud, that Mr. Espy's theory is suicidal, requiring the air to be colder to condense the vapour, and at the same time warmer, to produce an ascending motion, will satisfy the mind of any one who chooses to investigate the subject thoroughly; for he will perceive that neither of these conclusions follows from the doctrine which I teach.

The foundation on which I build must be sapped, before the superstructure can be overthrown. Let any one try the following experiment, and he will be able to tell whether my corner stone is firmly laid or not. Try how much the temperature of both dry air and air saturated with aqueous vapour is reduced in temperature by a given diminution of pressure, and if he finds, at ordinary summer temperatures, the moist air reduced only about one half that of dry air, as I have found it, he will, by careful examination, be able to perceive, that all the doctrines which I teach on this subject follow as corollaries from this single fact, in connexion with other facts heretofore established.

JAMES P. ESPY.

Franklin Institute.

Annual Meeting.

The Annual Meeting was held at the Hall of the Institute, on Thursday evening, January, 18th, 1839.

James Ronaldson, Esqr., President, in the Chair;

Isaac B. Garrigues, Esqr., Recording Secretary.

The minutes of the last Quarterly Meeting were read and approved.

Donations were received from the Royal Geographical Society of London; the Royal Irish Academy of Dublin; Samuel M. Stewart, Wm. Boardman, Jr., and Abraham Miller, Esqrs., of Philadelphia; Capt. Gwyn, United States Navy, and Hon. John Fine, per J. J. Barclay, Esqr., Messrs. Baughman and Geauteau, of Pennsylvania, and Mr. N. Scholfield.

The Actuary laid on the tables the periodicals received in exchange for the Journal of the Institute, during the past quarter.

The annual report of the Board of Managers was read and accepted, and referred to the Committee on Publications.

The Treasurer presented his report of the funds for the last quarter, and also a statement for the year ending December 31st, 1838—which were read and accepted.

The Committee on Publications presented their report on the operations of the Journal of the Institute, for the past year, which was read and accepted.

Mr. Edwin Greble, from the Committee of Tellers of the annual election of Officers and Managers of the Institute, for the ensuing year, (appointed at the preparatory meeting, this day,) presented their report of the result of the election, when the President declared the following as duly elected:

James Ronaldson, President.

Isaiah Lukens, Thomas Fletcher, } Vice Presidents.

Isaac B. Garrigues, Recording Secretary.

Isaac Hays, M. D., Corresponding Secretary.

Frederick Fraley, Treasurer.

Managers.

Samuel V. Merrick,	John C. Cresson,
Abraham Miller,	Andrew M. Eastwick,
William H. Keating,	Isaac P. Morris,
John Struthers,	Charles B. Trego,
Matthias W. Baldwin,	Henry Troth,
Alex. Dallas Bache,	John S. Warner,
J. Henry Bulkley,	William H. Carr,
Alexander Ferguson,	Robert M. Patterson,
John Agnew,	Henry D. Rogers,
John Wiegand,	John Gilder,
Alexander M'Clurg,	Ambrose W. Thompson,
Samuel Hufty,	George Taber.

(Extract from the minutes.)

James Ronaldson, *President.*

Isaac B. Garrigues, *Rec. Secr'y.*

Fifteenth Annual Report of the Board of Managers of the Franklin Institute, of the State of Pennsylvania, for the promotion of the Mechanic Arts.

In conformity with the requisitions of the constitution, the Board of Managers present to the Institute their report of the various departments of business which have claimed their attention during the past year.

As one of the leading objects of the Institute, from its commencement, was the acquisition of a good Library, this subject has necessarily received the due attention of the Board.

During the past year there has been added to the Library 316 volumes. Of these, 142 were by purchase, 48 by exchanges, and 126 by donations. The Library now contains 2,200 volumes, embracing the most valuable works in all the various departments of science and the arts; and has cost the Institute, since its establishment, the sum of $5,562.23: of this amount $265.17 has been expended during the past year.

The Library is divided into two classes; the first comprising such works as, from their rarity, value or extent, ought not to be lent out; and also all unbound periodicals, and such text books as ought constantly to be found in a library of reference.

The second class includes all other books intended for circulation among the members.

The extent to which the library is used, affords the most gratifying evidence of its utility.

The Journal of the Institute merits a more extensive patronage. Many of its leading articles have been re-published in Europe; and with such commendations as are highly flattering, both to the Institute and the cause of American science. It is to the Journal that we are indebted for the valuable exchanges which are spread upon the tables of our reading room.

The success attending the lectures of the Institute, is gratifying in the highest degree, and is the best evidence the Board could desire, that the lecturers are eminently qualified for the duties they have assumed.

The only cause for regret is, that the lecture room does not afford sufficient accommodation for all who desire to receive instruction. In addition to the regular tickets furnished to the members, there have been sold 295 minor's tickets, 75 ladies' tickets, and 19 tickets to strangers. Dr. J. K. Mitchell continues to fill the chair of chemistry, Jno. C. Cresson, Esqr., that of natural philosophy, and James C. Booth, Esqr., that of Technology.

The departments of architectural and miscellaneous drawing, are under the superintendence of Mr. W. Mason, and Mr. Jno. M'Clure. The number of pupils is 97. Large as this number is, it is limited only by want of more liberal accommodations. During the past year there have been several valuable additions made to the cabinet of models; but the Board have been prevented, by want of a suitable room, so to arrange and exhibit the models as to do justice to the Institute.

The arrangement of the cabinet of minerals is completed; it occupies an entire room, and in variety and extent is but little inferior to any other cabinet in the city. Arrangements have been made for the preparation of a catalogue of all it contains.

It is a source of satisfaction to the Board, to witness the interest which is taken in the reading room; it is the place in which a large proportion of the members daily spend a profitable hour. There are received there thirty-

four newspapers, and thirty-eight periodicals; of the periodicals, nineteen are English, seven French, and twelve American. The Journal of the Institute affords a sure guarantee that these sources of improvement will steadily increase.

The exhibition of American manufactures, held by the Institute, in November last, exceeded the most sanguine expectations of the Board. The articles, with very few exceptions, were not prepared for special exhibition; beautiful as the specimens exhibited generally were, they are only to be regarded as fair samples of American skill, such as are to be found constantly in our warehouses and shops. In extent and variety they far exceeded any similar exhibition ever held in this country.

A detailed report of the exhibition is expected shortly from the committee to whom the subject is assigned, which will be duly submitted to the Institute.

The Board of Managers acknowledge their indebtedness to the members of the Institute, and to other gentlemen for their services in arranging the various specimens for exhibition. It will be gratifying to the Institute to learn that notwithstanding the immense concourse of visitors, nothing occurred at any time to disturb the company: the arrangements of the committees were wisely made, and conformed to with strict propriety.

The appropriation made by the legislature, to the Institute, for meteorological observations, was, until within the last six months, under the control of a joint committee, composed partly of members of the Institute, and partly of members of the American Philosophical Society. The committee thus constituted, were at a loss to determine to which body they were accountable. Finding themselves thus embarrassed, that portion of the committee appointed by the Philosophical Society, were discharged by that body, and the Board immediately appointed a standing committee on the subject of meteorology, and have charged them with the duty of carrying out the design of the legislature.

This committee have entered upon the prosecution of their duties with spirit: several reports of the results of their labors have been spread before the public through the Journal of the Institute.

The committee on science and the arts, have examined, during the past year, the merits of various projects and machines which have been submitted to them: upon fifteen they have reported in detail. These reports, unless otherwise ordered, have been published in the Journal.

Experience thus far proves the utility of this committee. It not unfrequently happens that the novice in science or arts is saved much fruitless toil and expense by their investigations.

The Board regret that they have been unable, as yet, to enter into any arrangements for the erection of a new hall. The embarrassments in which the commercial community has been so recently involved, preclude the hope that so desirable an object can be speedily attained. Until trade shall again flow on in its accustomed channels, and industry and successful enterprise shall seek investments for their rewards, the erection of a new hall must be postponed.

The Board, however, have the satisfaction to state that their property on Chesnut street is not at present a source of embarrassment to the Institute—the income from it is adequate to meet all the expenses.

Nothing further has been done towards the establishment of a School of Arts. It was the design of the Board to make an early and vigorous ap-

peal to the legislature for the necessary aid to establish such a school. In this design they were frustrated by the difficulties attending the organization of one of the legislative branches.

As these difficulties have terminated, it is earnestly recommended to our successors in the management of the Institute, as early as possible again to press this subject on the attention of the legislature.

During the past year there have been elected five hundred and ten new members, seventy have resigned, and five deceased. Jno. C. Hunter, Chas. Brown, Wm. Struthers, Jno. Reeves, Edward Henderson, E. A. Etting, Jno. F. McNabb, Geo. Wilmer, Wm. Wright, Jno. White, Thos. A. Biddle, Clement Biddle, Jr., and Wm. Harris, have become members for life.

In reviewing their labors, the Board of Managers feel that while they have been prevented, by obstacles totally beyond their control, from accomplishing all the desirable objects entrusted to their care, the main designs of the Institute have been steadily advancing.

In carrying out these designs, the Board have always found in the Actuary of the Institute, a prompt and efficient agent. During the suspension of specie payments, the former Board, in order to meet their engagements, authorized the issue of certificates of loan, bearing interest. Notwithstanding a portion of these loans was irredeemable until 1847, the Board have directed the Actuary to pay them off upon the presentation of the certificates. Of the whole amount issued, there remains yet unpaid, about $600. This balance the Actuary is prepared to meet on demand.

For the condition of the finances, the Institute is respectfully referred to the annual report of the Treasurer, which is herewith submitted.

It is now fifteen years since the Franklin Institute was numbered among the associations for the promotion of science and the arts. From an extremely limited number, with which its existence commenced, it now enrolls the names of 2,513 members. From the novel character of the institution, its founders had many prejudices and difficulties to encounter; they were destitute of that practical wisdom which experience in the management of similar institutions, could afford. There was nothing in our own country like it, unfolding to the comprehension of the unlearned practical man the various processes of his art. It would scarcely be justice to the founders of the Franklin Institute, to say that they were men of enlarged and liberal views, they were more, their plans were wisely laid and successfully prosecuted. Of this, the prosperity of the Institute, and its reputation both at home and abroad, are sufficient proofs. Nor have the benefits of the Institute been confined exclusively to the man of science and the artisan. Its lectures are now regarded, by many of our most worthy citizens, as indispensable to the education of their children. For the cause of education the Institute has effected much, and promises more. The youths who have been instructed, and those who are now receiving instruction, in our lecture room, have yet to exert their influence in the cause of education. The tastes for knowledge which shall be there induced *will* be gratified. Philadelphia now more than creditably sustains a number of lecturers on general literature and science, who a few years since could not have obtained an audience to encourage them. May not these popular evidences of intellectual taste and improvement, be regarded as some of the fruits of the Franklin Institute. For the manufacturer and mechanic, the Institute has unquestionably accomplished much; it has been steadily and securely elevating their professions to a level with those which were once regarded as

the exclusively learned; it has removed the prejudices which were once associated with the pursuit of mechanics, and taught this practical lesson, that moral and intellectual worth makes the man.

JOHN WIEGAND, *Chairman.*

WILLIAM HAMILTON, *Actuary.*
Philadelphia, Jan. 16th, 1839.

Minutes of the Board of Managers.

At a meeting of the Board of Managers, held at the Hall of the Institute, January 23d, 1839,

Mr. JOHN AGNEW was elected Chairman of the Board; and

Messrs. JOHN C. CRESSON, and HENRY TROTH, Curators for the ensuing year.

At a meeting of the Board, held February 20th, the Chairman nominated the Standing Committees agreeably to the By-Laws. On motion, Alfred Langdon Elwyn, M. D., was added to the Committee on the Library; Messrs. Jno. Agnew, John McClure, and Thomas S. Stewart to the Committee on the Cabinet of Models; Mr. James C. Booth to the Committee on the Cabinet of Minerals; Mr. John Agnew to the Committee on Premiums and Exhibitions; Professors Roswell Parke, Robert Hare, and John K. Mitchell to the Committee on Monthly Meetings; Messrs. Charles Thomas, Jacob Bennet, and William Kirk to the Committee on the Exchange; and Robley Dunglison, M. D., Messrs. James P. Espy, Charles N. Bancker, John K. Kane, Sears C. Walker, and Gouveneur Emerson, M. D. to the Committee on Meteorology; when the committees were appointed as follows:—

On the Library.

Henry Troth, *Chairman.*	J. Henry Bulkley,
Isaac Hays, M. D.,	Robert M. Patterson, M. D.,
Alex. Dallas Bache,	Ambrose W. Thompson,
Isaac P. Morris,	Alfred L. Elwyn, M. D.

On the Cabinet of Models.

Isaac P. Morris, *Chairman.*	John Gilder,
John Struthers,	George Taber,
Andrew M. Eastwick,	John Agnew,
Isaiah Lukens,	John McClure,
William H. Carr,	Thomas S. Stewart.

On the Cabinet of Minerals.

Charles B. Trego, *Chairman.*	Abraham Miller,
Isaiah Lukens,	Henry D. Rogers,
William H. Keating,	Thomas Fletcher,
Samuel Hufty,	James C. Booth,

On Publications.

Isaac Hays, M. D., *Chairman.*	Matthias W. Baldwin,
Alex. Dallas Bache,	John C. Cresson,
Samuel V. Merrick,	Robert M. Patterson, M. D.

On Premiums and Exhibitions.

John C. Cresson, *Chairman.*
William H. Keating,
Alexander Ferguson,
Thomas Fletcher,
Isaac B. Garrigues,
Alexander M'Clurg,
John S. Warner,
John Agnew.

On Instruction.

Alex. Dallas Bache, *Chairman.*
Frederick Fraley,
John Wiegand,
Isaac P. Morris,
Abraham Miller,
Charles B. Trego,
Henry Troth,
Henry D. Rogers.

On Monthly Meetings.

John C. Cresson, *Chairman.*
Andrew M. Eastwick,
Henry D. Rogers,
John S. Warner,
William H. Carr,
Roswell Parke,
George Taber.
Alex. Dallas Bache,
John Wiegand,
Robert M. Patterson, M. D.,
Robert Hare, M. D.,
J. Henry Bulkley,
John K. Mitchell, M. D.,

On the Exchange.

John S. Warner, *Chairman.*
John Struthers,
Andrew M. Eastwick,
Isaac B. Garrigues,
John Gilder,
Charles Thomas,
Jacob Bennet,
William Kirk.

On Finance.

William H. Keating, *Chairman.*
Samuel V. Merrick,
Alexander Ferguson.
Frederick Fraley,
Henry Troth.

On Meteorology.

Robley Dunglison, M. D.,
Charles N. Bancker,
Henry D. Rogers,
Robert M. Patterson, M. D.,
Gouveneur Emerson, M. D.
James P. Espy,
John K. Kane,
Sears C. Walker,
John C. Cresson.

Managers of the Sinking Fund.

Samuel V. Merrick, *Chairman.*
Frederick Fraley.
Alexander Ferguson,

Auditors.

Isaac B. Garrigues,
William H. Carr.

(Extract from the minutes.)

JOHN AGNEW, *Chairman.*

WILLIAM HAMILTON, *Actuary.*

COMMITTEE ON SCIENCE AND THE ARTS.

Report on William Jenks' Improved Fire Arms.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination an improvement in Fire Arms, invented by Mr. William Jenks, of Springfield, Massachusetts, REPORT:—

That the improvement consists of a piston or plunger, fitting in a chamber in the breech of the piece, which is drawn back by a lever and several pieces of metal, so as to permit the ball and charge of powder to be put into the chamber through an opening in the upper part of the breech. After which, the lever being depressed, the piston is forced forward by the above mentioned pieces of metal, which constitute, by their position, a species of toggle-joint. When the charge has thus been forced home, the joints are a little beyond a straight line, from the breech to the extreme point of action. It follows, as a necessary consequence, that the piston cannot be forced back by the discharge of the piece, and requires no fastening of any kind.

The Committee is of opinion that the invention of Mr. Jenks is a simple, safe and efficient improvement in the construction of fire arms, that it presents very little difference to the eye, from guns of the ordinary construction, and is, as far as they perceive, free from all the objections which usually accompany breech loading, and possesses all its advantages.

By order of the Committee.

WILLIAM HAMILTON, Actuary.

December 13, 1838.

Thomas Oliver's System of Cutting Garments.

To the Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania.

The Sub-Committee to whom was referred the consideration of Mr. Thomas Oliver's publication of an erroneous report purporting to emanate from the Committee on Science and the Arts of the Franklin Institute, REPORT:—

That at the request of Mr. Oliver, a sub-committee was appointed to examine his system of cutting garments, who made a report generally favourable to that system; a copy of which was furnished to Mr. Oliver. The present sub-committee find that on publishing that report, Mr. Oliver has added in the body of it the following paragraphs,—

"*This great desideratum the Committee think has never been attained by any other method of drafting.*"

"*Various systems of cutting have appeared within the last few years, all, or nearly all, of which have been examined by members of this Committee, but, without wishing to detract from the merits of any other system, not one so far has been found entirely to answer the purpose for which it was intended.*"

The following paragraph, viz. "The Committee believe that Mr. Oliver's system is calculated to obviate the difficulty under which tailors have laboured,"

Mr. Oliver has altered to read

The Committee believe that Mr. Oliver's system is *better* calculated to

obviate the difficulty under which tailors have laboured, *than any of the above named systems.*

Another paragraph, viz. "One member of this Committee has tested the system by cutting a number of coats by it, and does not hesitate to give it his unqualified approbation,"

He has changed to read

Several of the Committee have tested the system by cutting a number of coats by it, and *they do* not hesitate to give it *their* unqualified approbation.

By instructions from this Committee, the Actuary had an interview with Mr. Oliver, who acknowledged the alterations, and promised to make a public acknowledgment of the fact, but the Committee have since understood that he has left the city with an intention of going to Europe, without having complied with this engagement. This Committee, therefore, recommend that the above statement should be laid before the public, in justice to other persons interested in the case, and as an act of duty on the part of the Institute.

By order of the Committee.

WILLIAM HAMILTON, Actuary.

February 14th, 1839.

English Patents.

Specification of a patent granted to JAMES HELLEWELL, *of the county of Lancaster, Dyer, for his invention of an improved process or manufacture, whereby the texture of cotton and certain other fabrics and materials, may be rendered impervious to water.* [Sealed 28th November, 1835.]

These improvements, in the process whereby the texture of cotton and certain other fabrics and materials may be rendered impervious to water, consist in steeping the fabric, intended to be made waterproof, in a peculiar solution, which has been previously prepared for the purpose, in vats or cisterns of any required dimensions and material, and which are to be situated in any convenient position, so as to carry on the process to the required extent, and in the most advantageous and convenient manner to the operator. It is generally known that the water-proof cloths which have been found superior to others, and which have been mostly adopted for the purposes of wearing apparel and other similar uses, are composed of two pieces of material cemented together with a preparation of caoutchouc, or other material, and thereby rendered totally impervious to air as well as water, which fabrics (usually called "double texture,") are exceedingly detrimental and repulsive to the action of natural perspiration, to obviate which defects my improvements are principally designed, and the expense of rendering manufactured articles perfectly water-proof is greatly reduced by their being of single texture only, and merely steeped or saturated in the solution hereafter described, which is found to make it repel the action of the water, and prevent its running through the fabric, and at the same time leaving the fibres of the cloth sufficiently open to allow the necessary passage of air.

I presume, as the principal feature of novelty and improvement is now understood, and the object of my invention sufficiently explained, a description of the ingredients and their relative quantities will only be needful to render my invention fully and most perfectly understood; and as by

experience I have found that dyers, and persons accustomed to use such like processes, in general mix their solutions with particular regard to the weight of the manufactured material to be steeped therein, and without any reference to its length or width, (which is always so much more variable than its weight) I shall describe my process in pursuit of the same plan, being most approved, and generally found the most correct. The mixture of ingredients I have hereafter described, will be found the best quantity in which to saturate fabrics to the weight of 1000 lbs. avoirdupoise. When the cisterns or vats have been previously disposed so as to contain the proper quantities of materials, mix in one large vessel (which may be subsequently divided) about 200 gallons of water with about 120 lbs. of common alum in its crystalized state, commonly called rock alum, and for the purpose of rapid dissolution, I prefer that the alum should be previously ground or pulverized; to this mixture add, in small quantities, about 80 lbs. of whiting (chalk cleared of impurities and ground in a mill.) It will now be found by this addition, a considerable effervescing action has taken place, and a chemical change has also been effected, whereby the sulphuric acid, of which the alum principally consists, is perfectly destroyed, and the alumina, which is the residuum I require, left entire; now the alumina being in a state of solution, and remaining with the water, the whiting and other unnecessary parts will precipitate and remain at the bottom of the vessel; when entirely cold, the liquor may be drawn off, leaving the impurities and sediment in the bottom of the vessel in which the preparation has been made, and in this state is ready for immediate use. The cloth or fabric intended to be saturated is now to be introduced into suitable vessels containing the above mentioned solution, and either allowed to remain, to be thoroughly steeped, or merely passed through the solution, as found most convenient, provided that the cloth is sufficiently saturated. I also wish it to be understood that I have found acetate of lead (sugar of lead) to have the same effect in destroying the sulphuric acid contained in the alum, but it is much more expensive, besides leaving a quantity of acetic acid in the solution, which will be found injurious to many colours, of which the fabrics may happen to have been dyed. The cloth is now to be taken to a vat or vessel containing a mixture of water with common yellow soap, allowing about 3 lbs. of soap to every 50 lbs. of cloth, and to be mixed with about 30 gallons of water, either more or less, as shall be found by the experience of the operative to have the desired effect; the soap may either be dissolved by boiling, or cut into pieces and boiling water poured on to it, and when it has cooled to about 100 degrees Fahrenheit, the cloth is to be passed quickly through the solution in the most convenient manner. This part of the process is for the purpose of strengthening the repellant qualities of the cloth, which have been subjected to previous saturation, and fastening the alumina, which has been taken up by the cloth during the former process, that is, preventing it from being washed out or destroyed. By way of cleansing the fabric, which is now rendered perfectly repellant and impervious to water, from any impurities, such as soap lees or other extraneous matter which it may have taken up during its passage through the processes above described, I now pass the same through cisterns of clear water, in any convenient manner, and after being dried the cloths are ready for use, some qualities of which may require to be finished or calendered in the usual manner. Although the principal object of this invention is intended to be used for such goods or materials as are manufactured from cotton, I wish it to be understood that I will not confine myself to that fabric alone,

as it must be evident that wool, silk, linen, or any other fibrous substance, may be subjected to similar processes with the same advantageous effect. Nor do I mean to confine my claim to the use of the precise quantities here specified, as they are mentioned merely for illustration, and are such as I have found to be most convenient and beneficial. Lond Journ. Arts & Sciences.

Specification of a Patent granted to FRANCIS MOLL, *of the county of Surrey, for his improvements in preserving certain vegetable substances from decay.* [Sealed 19th January, 1836.]

This invention is for impregnating timber with two products of coal tar, which the patentee denominates enpion and kreosot. These products are obtained in the following manner:—A quantity of coal tar is put into a still, and a gentle heat is applied, until a vapour comes over; which vapour is to be condensed in the ordinary manner. The distilling operation should be continued until the enpion has acquired about the same specific gravity as water.

This product, when in its pure state, the patentee informs us, is called by English as well as German chemists, "enpion;" and although it is not exactly in a pure state when obtained, as above described, it is of sufficient purity for the purposes to which it is to be applied by the patentee. The "enpion" obtained as above described, will be found, upon testing it with the proper tests, such as litmus paper, &c. to contain acids; these acids, however, may be got rid of by washing the enpion with lime or other alkaline water, or a quantity of dry lime may be mixed with the coal tar to neutralise the acid; and if water is distilled over with the enpion, the enpion will be found floating on the surface of the water, and may be drawn off.

The next product is obtained by raising the coal tar in the still to a very high temperature, when a further vapour will come over freely, leaving only the pitch in the vessel; this is also to be condensed in the same manner as the enpion, and is called by English as well as German chemists, "kreosot." This product may also be subjected to the action of lime water, to free it from any acids, if thought desirable. When these products are obtained, the patentee applies them to the timber in the following manner:—

A cast iron tank or chamber is to be constructed in any convenient manner, and the timber placed therein in such a manner that the vapour of the enpion and kreosot may have free access to all parts of it. The temperature of this chamber should be raised to about 90 or 100 degrees of Fahrenheit's thermometer, by steam pipes or any other convenient means.

Previous to allowing the vapour to enter, it is requisite that this operation should be performed so that the enpion may be allowed to flow into the chamber in a state of vapour and fill it; and it is also required to expel any degree of moisture from the timber.

After the chamber has been heated a sufficient time, the water that has been expelled from the timber by the heat, should be drawn off, and the vapour of the enpion should then be allowed to enter and diffuse itself throughout the chamber, when it will impregnate the timber. When the timber has been sufficiently impregnated with enpion, the enpion should be drawn off and the vapour of kreosot must then be allowed to enter from the still; and the kreosot will be found to have such an affinity for the enpion, that it will speedily impregnate the whole of the timber wherever the enpion has

gone, the enpion acting as a guide, and the kreosot itself being the antiseptic. The chamber should then be filled with hot kreosot in its liquid state, and be allowed to remain some time.

The patentee here states, that it is impossible to lay down any rule as to the time required for each operation, as the nature of wood differs so materially even among the same species; but that experience will easily teach the workman; and it would be as well to observe that a small test chamber would greatly facilitate the operations of the workman, as he can try experiments upon small pieces of the timber, and calculate from the results obtained how long it will be required to keep the log in the chamber. The timber should be arranged vertically in the chamber if it can be conveniently managed, but if not, it should be placed on an iron grating at the bottom of the chamber, and so arranged that every part of the timber may be acted on by the enpion and kreosot.

The patentee here remarks, that the products of enpion and kreosot may be obtained from other substances than coal tar; but that he prefers obtaining these products from the last mentioned material, owing to its cheapness; and also, that he is well aware that coal tar and such like substances have been heretofore used for the purpose of preserving timber; he, therefore, does not claim, as his invention, the use of tar for this purpose, but only the use of the two before named products, viz. enpion and kreosot, which impregnate the wood and penetrate as far as the heart, and effectually preserve it from the effects of dry rot. Ibid.

Specification of a patent granted to PETER SPENCE, *of the county of Middlesex, for his invention of certain improvements in the manufacture of Prussian blue, prussiate of potash, and plaster of Paris.*—[Sealed 27th July, 1837.]

These improvements consist in the following modes or manners of manufacturing the aforesaid articles, in which I particularly state the various processes that I adopt, and the various materials that I use in my aforesaid manufacture: and first, with regard to the materials from which I produce my aforesaid articles of manufacture, be it known that I use for this purpose the refuse lime liquor of the gas works, being the bright liquor that swims on the top of the muddy impure lime, after they have been emptied out of the purifying vessels of those gas works which purify their gas by the wet lime, or cream of lime, process; which liquor is named in many of the aforesaid works blue billy liquor. I also use for my aforesaid manufacture the refuse dry lime of those works which use the dry lime mode of purifying, being the aforesaid dry lime after it is taken out of the purifying vessels. I also use various secondary articles, which I shall name when I come to specify the processes in which they are used. From the aforesaid lime liquor I manufacture Prussian blue, prussiate of potash, and plaster of Paris; and from the aforesaid dry lime I manufacture Prussian blue and prussiate of potash. My modes or manners of operation, in my manufacture, are as follows: as I find that the liquors which I receive from the different works, and also those procured at different times from the same works, vary very much in strength, so I find it most profitable to separate the liquors into two distinct classes, according to their strengths, and to adopt two different modes of operation with them: the mode of operation

with the dry lime is also different from the other two modes with the two classes of liquors; so that altogether I have three different modes of operation, which I shall now make known in the order in which I have stated them, that is to say, the two modes of operation with the two classes of liquors, and the mode of operation with the dry lime. But first, I shall state my mode of classing the liquors. In the first class of liquors I place all the weak liquors, being those which require less than one pound of oil of vitriol for the saturation of an imperial gallon; and in the second class I place all the strong liquors, being those which require one pound and upwards of oil of vitriol for the saturation of an imperial gallon. My mode of testing to which class any liquor which I may procure belongs, is the following:—I measure off an exact gallon of the liquor to be tested, and pour it into an earthen jar that will contain from three to four gallons; I then weigh off in a bottle of any convenient shape two pounds of oil of vitriol or sulphuric acid, of the strength of 1.845; I then pour from this bottle a quantity of the acid into the liquor, and adding it gradually until the effervescence begins to grow weak, I then take a slip of litmus testing paper, and when I find that on dipping it into the liquor the paper is coloured red, I stop adding the acid; I then weigh the acid that remains, and the difference in weight is what is required to saturate a gallon of the liquor under trial: if it is less than one pound, then the liquor will belong to the first class, or the class of weak liquors; if it is one pound or more, then the liquor will belong to the second class, or the class of strong liquors.

I shall now describe my mode of operating upon the first class of liquors, being the class of weak liquors. These I receive into large wooden tanks or vats, containing from 4 to 5,000 gallons; in these tanks or vats, when nearly full, I put the liquor through the first or preparatory process; the liquor as I receive it from the works contains a solution of hydro-sulphuret of lime, and hydrocyanate of lime, or prussiate of lime; the real quantity of these being, of course, in proportion to the strength of the liquor; the relative quantities being in most liquors nearly 14 parts of hydro-sulphuret of lime to one part hydrocyanate or prussiate of lime. The object of my first or preparatory process, is to convert the hydrocyanate or prussiate of lime into ferro-hydrocyanate, or ferro-prussiate of lime, to prevent its decomposition in the second or saturating process; and this I effect in the following manner:—for every one hundred gallons of the liquor, I take ten pounds of green copperas, or sulphate of iron, and five pounds of newly slacked quick lime. I dissolve the copperas in water in one vessel, and mix the quick lime with water in another, till it is about the consistence of cream; I then add the solution of copperas to the lime, and after stirring them for a few minutes, pour them into the tank or vat of liquor to be operated upon; the whole body of the liquor must then be stirred for a quarter of an hour, and then be left for twelve hours, when it is ready for the saturating process. The saturating process I perform in the following manner:—the vessel in which I perform this operation is an air tight cask containing three hundred gallons; on the top of this cask I place a stone ware receiver, containing sulphuric acid, and having a stone ware cock fitted into it near the bottom. Below this cock is a funnel of sheet lead, which is soldered to a leaden pipe of one half inch internal diameter, and bent in the form of the letter S. The other end of this pipe is inserted into the top of the saturating vessel, which stands on end, and through this funnel and pipe the acid is conveyed into the liquor. I also insert through the top of the saturating vessel another tube, of three inches internal diameter, being of tin plate. This tube

rises up one foot from the top of the saturating vessel, and then bends off at a right angle, and is carried along horizontally. This tube is for the purpose of conveying away the sulphuretted hydrogen gas, which is thrown off in the saturating process; which sulphuretted hydrogen gas I make use of in a way that I shall afterwards describe.

Into the side of the saturating vessel I also insert a cock, to draw off a little of the liquor to ascertain when it is saturated. In the top of the saturating vessel I also make a round hole of three inches diameter, into which I fit a wooden plug, movable at pleasure. This hole is for the filling of the saturating vessel with the liquor to be saturated. In the side of the saturating vessel, close to the bottom, I make another hole of similar dimensions, into which a plug is also fitted. This hole is for the purpose of emptying the saturating vessel after the liquor is saturated. When I proceed with the saturating process, I draw off the bright liquor, free from any of the sediment from the first process vat, by means of a syphon, the saturating vessel being placed on a lower level: by this means I fill the saturating vessel three-fourths full; I then stop the syphon, put in the top plug into the saturating vessel, and open the cock of the stone ware receiver, allowing the sulphuric acid, or oil of vitriol, to flow in a stream the size of a goose quill. After allowing it to flow for about ten minutes, I draw off a wine glass full of the liquor from the cock in the side of the saturating vessel, for the purpose of testing it, to ascertain if it is saturated. The test I apply is the following:—I dissolve a small quantity of green copperas, or sulphate of iron, in a wine glass full of water; I then pour a small quantity of this solution into the wine glass full of liquor to be tested. If it is not saturated, the liquor immediately assumes a black colour; but if it is saturated, it immediately assumes a light green colour. When, by this means, I find that the saturating process is complete, I immediately stop the cock through which the acid flows. I now draw the plug which is close by the bottom of the saturating vessel, when the whole of the liquor flows out, conveying along with it the sulphate of lime, which the acid has precipitated or thrown down from the liquor. This stream of saturated liquor and sulphate of lime that flows from the plug hole, I receive upon a filter of coarse cloth in a frame five feet square, and suspended over a sunken wooden tank: the clear liquid passes through the filter and the sulphate of lime remains upon it. When it has ceased flowing from the saturating vessel, I immediately replace the plug, and the saturating vessel is then ready for another operation. I then pour three or four pails full of water upon the mass of sulphate of lime on the filter, to drain through any liquor that remains among it. The sulphate of lime is then removed, and from it I manufacture my plaster of Paris in the following manner:—

After making a large bed of about three feet in thickness on any convenient piece of ground, I allow it to remain there for about six months, to drain thoroughly through the action of the rain; I then take it up, and after being burnt or boiled in the ordinary way of manufacturing plaster of Paris from native gypsum, it is then fit for the market.

The saturated liquor, after it passes through the aforesaid filter, is then pumped up into wooden tanks or vats, containing one thousand gallons each. When one of these is filled, I add to it a solution in water of sixty pounds green copperas, or sulphate of iron; a precipitate of a light green colour in a short time falls down from the liquor. The clear liquor is drawn off from this, and run away; fresh water is added, is allowed to settle, and again drawn off; and this is continued till the water comes off tasteless.

The precipitate is then thrown on filters, when it is brought to the consistence of a pulp or paste. This I call my coarse blue, and from it in this state I make fine Prussian blue and prussiate of potash. To make Prussian blue, I proceed in the following manner:—for every one hundred pounds of the pasty coarse blue, I take fourteen pounds of soda of commerce, or an equivalent quantity of other alkali; I dissolve it in ten gallons of water: this solution I bring to a boiling heat, and pour it upon the pulpy coarse blue; I then stir it at intervals for three hours; I then allow it to settle, then draw off the clear liquor, and throw the sediment on a filter, that what remains may drain from it. To every gallon of this liquor, I add a solution of one pound of green copperas, or sulphate of iron, which throws down a dark green precipitate; to this I add muriatic acid, or spirit of salt, till it assumes a deep blue colour; it is then washed till the water comes off tasteless, thrown upon filters, from them placed on chalk stones in a drying house, and then dried off on iron plates exposed to the temperature of from one hundred and fifty to two hundred degrees of Fahrenheit.

In making my prussiate of potash from the pulpy, coarse blue, I proceed in the following manner:—for every one hundred pounds of pulpy, coarse blue, I take nine pounds of the potash of commerce, and dissolve it in two gallons of water; I then add to it the pulpy blue, and bring up the whole to a heat of one hundred and fifty degrees of Fahrenheit. I keep it at this for three hours, with frequent stirring; I then allow it to settle, draw off the clear liquor, throw the sediment upon a filter, and wash out what remains with a little water. I then evaporate the whole of this clear solution till a pellicle forms upon its surface, when I draw it off to crystallize.

The sulphuretted hydrogen gas, which I described before as being carried off in a tube of three inches diameter, I make use of in the following manner:—I carry it onwards to a leaden chamber, constructed upon the ordinary plan of manufacturing sulphuric acid, or oil of vitriol. When within ten feet of the furnace of the chamber, I bend the pipe into an air tight cask three-fourths filled with water, the pipe opening two inches below the surface of the water; the use of this is to prevent explosions of the gas when it gets mixed with air; another pipe of the same size that does not enter the water, conveys the gas to the furnace, when, being lighted, it burns with a large blue flame, and is converted into sulphurous acid gas and watery vapour: these are conveyed by a large pipe into the chamber, when the sulphurous acid gas is converted into sulphuric acid, by the same means as when it is obtained by the burning of brimstone. My sulphuric acid thus produced, I use in my saturating process.

I shall now describe my method of operating upon the second class of liquors, being the class of strong liquors. In operating upon them, I proceed upon the principle of converting the hydro-sulphuret of lime into a sulphuret of lime, at the same time converting the hydrocyanate of lime or prussiate of lime into a ferro-hydrocyanate or ferro-prussiate, to prevent its decomposition; this I effect by the following method:—for every one hundred gallons of the liquor to be operated upon, I take six pounds of green copperas, or sulphate of iron, and dissolve it in sixteen gallons of water; to this I add two gallons of the ammoniacal liquor of the gas works: I then allow the precipitate to settle, pour off the water, and put on fresh water; repeating this till the water comes off tasteless; I then put the sediment among the liquor to be operated upon, then put the whole into an evaporating vessel, and evaporate it down to perfect dryness, taking care that the heat be so moderated in the last stage of the process, as not in the least de-

gree to burn it; I then take the residual substance out of the evaporating vessel, and reduce it to a coarse powder; and from this powder I produce Prussian blue and prussiate of potash in the following manner:—to make Prussian blue, for every one hundred pounds of the coarse powder, I take fourteen pounds of the soda of commerce, or an equivalent quantity of other suitable alkali, and dissolve it in sixteen gallons of water; this I bring to a heat of one hundred and fifty degrees of Fahrenheit; I then pour it on the powder, and stir every quarter of an hour for three hours, I then allow it to settle, draw off the clear liquor, throw the sediment upon a filter, and pour over it six gallons of water, at one hundred and fifty degrees Fahrenheit; I add the liquor which comes through the filter to that which was poured off; I then put the whole into a pan, and bring it to a boil; I now add to it a substance that will abstract a quantity of sulphur, which the soda has dissolved, and holds in solution for this purpose. I can use the black oxide of manganese, or the yellow oxide of lead, named litharge; but I prefer using, as cheaper, the red oxide of iron, obtained from the decomposition of pyrites by heat: this I reduce to powder, and wash thoroughly, to separate any sulphate of iron that might cling to it, for the quantity of liquor to be operated upon as aforesaid. I take a quantity of this oxide of iron, equal to six pounds of it, in a dry state, and put it into the boiling liquid, stirring till it be thoroughly mixed, then boil it for ten minutes, and then empty it into a settling vessel; when the liquor brightens, it is drawn off, the sediment thrown upon a filter, and any that may remain among it is washed out with two or three gallons of water: to this clear solution I now add eight pounds of green copperas, or sulphate of iron, dissolved in water, which throws down a dark green precipitate; on this I pour muriatic acid, or spirit of salt, till it assumes a deep blue colour; it is then washed, filtered, and dried, in the same way as the Prussian blue from the first class of colours.

To make prussiate of potash from my aforesaid coarse powder, I proceed as follows:—for every one hundred pounds of the coarse powder, I take eight pounds of the potash, or nine pounds and a half of the pearlash of commerce, and dissolve it in twelve gallons of water, bring the solution to a heat of two hundred degrees of Fahrenheit, and then pour it on the coarse powder; I stir it frequently for two hours, and then add eight gallons of water at a boiling heat, stir, and then allow it to settle; I draw off the clear liquid, throw the sediment on a filter to drain, and then wash it through with six gallons of water, at two hundred degrees of Fahrenheit: the liquor passed through the filter I add to that drawn off; I put the whole into a pan, and bring it to boil; I then add eight pounds of the aforesaid oxide of iron, and boil for ten minutes; it is then drawn to separate the sediment, after which the bright liquor is returned into the evaporating pan and boiled down till a pellicle forms on its surface, when it is drawn into the crystallizing vessel to crystallize.

I now come to describe my process with the refuse dry lime of those gas works which use the dry lime mode of purification, being the aforesaid refuse dry lime after it is taken out of the purifiers, this I find to contain chiefly sulphuret of lime (or calcium.) carbonate of lime, and cyanide of lime (or calcium;) and the two former not being soluble to any great extent, while the latter is converted into hydrocyanate, and dissolved when it comes into contact with water: in accordance with these statements, I proceed in the following manner:—having put a quantity of the dry lime into a large wooden vat, I let in water heated to about one hundred and fifty degrees of Fahrenheit, till the lime is thoroughly soaked, and the water

stands about a foot above the mass, and then it is beaten about till well broke; it is then allowed to remain, with occasional stirring, for eight hours, when it is allowed to filtrate out by a cock at the bottom of the vat; this liquor is set aside for using at once:—more water is then added to the mass, is allowed to filtrate through, and is then used for another quantity of dry lime.

To make Prussian blue from the aforesaid liquor first run off, I proceed as follows, and I bring the liquor to boil:—for every one hundred gallons, I use twenty pounds of the dry oxide of iron, allow it to boil for ten minutes, and withdraw it into a settling vessel; when well settled, the liquor is drawn off; to this liquor I then add a solution of muriate of iron, as long as any precipitate is thrown down; muriatic acid, or spirit of salt, is then added, until it assumes a deep blue colour; it is washed, filtered and dried, in the same manner as before specified.

To make prussiate of potash from the before-mentioned liquor, I dissolve a quantity of the potash or pearlash of commerce in as small a quantity of water as will dissolve it; I then add it to the liquor as long as a white precipitate is thrown down; I then allow this precipitate to settle, and draw off the clear liquor, bring it to boil, and for every pound of alkali used, I take a pound of the red oxide of iron, boil it ten minutes, then withdraw it to separate the oxide; I then return the liquor into the evaporating pan, and boil down till a pellicle forms on its surface, when it is run into the crystallizing vessels to crystallize.

Having thus described the nature of my invention, and the manner of carrying the same into effect, I would remark, that I lay no claim to the producing sulphuric acid from the sulphuretted hydrogen, evolved in what I have called the saturating process; and I have only mentioned it for the purpose of pointing out the most advantageous mode of carrying on the other processes; nor do I claim the production of prussiate of potash from Prussian blue generally, and I am aware that Prussian blue, admixed with sulphate of lime, has been proposed to be obtained from lime liquor; I do not, therefore, claim the manufacture of a product so combined, or in a state of admixture the one with the other; but what I do claim as my invention is, first, the production of the three separate products, Prussian blue, prussiate of potash, and plaster of Paris, or either of them, uncombined with other matter, from what I have called weak liquors, being the refuse lime liquors of the gas works, as above described.

Secondly, the producing the two separate products, Prussian blue and prussiate of potash, or either of them, uncombined with other matter, from what I have called strong liquors, being the refuse lime liquors of gas works, as above described.

And, thirdly, I claim the production of Prussian blue and prussiate of potash, or either of them, uncombined with other matter, from the refuse dry lime after it has been employed for the dry lime process of the gas works, as above described. Ibid.

Specification of a patent granted to CHRISTOPHER NICKELS, *of the county of Surrey, for improvements in preparing and manufacturing caoutchouc, applicable to various useful purposes, being partly a communication from a foreigner residing abroad.* [Sealed 24th October, 1836.]

The subjects of invention claimed under this patent, are described under

seven heads: first, a mode of producing threads of caoutchouc from the refuse strips or cuttings; second, machinery for producing the first described object; third, cutting off threads from the edges of a series of disks of caoutchouc; fourth, spirally twisting round strands of caoutchouc, yarns of cotton or silk, or other fibrous materials, for the purpose of guarding the caoutchouc from wear; fifth, rendering fabrics water-proof and air-tight by means of caoutchouc, without dissolving it; sixth, weaving elastic ornamental webs or fibres; and seventh, the application of caoutchouc to the purposes of binding and covering books.

Under the first head, the patentee describes the ordinary methods of cutting bottle or cake India rubber into thin strips; and states that a great waste of the material takes place from the quantity of small pieces which are pared off and become refuse and useless.

These refuse pieces the patentee washes in hot water, in order to remove all the dirt, and then introduces them into a sort of mill, where they are ground and masticated; and the caoutchouc, after thus treated, is discharged in a plaster, or semi-fluid state. The caoutchouc, so prepared, is then put into a powerful hydraulic press, and kept in that press until it becomes set, and sufficiently hard to be cut into sheets or strips.

The internal form of the receiving vessel of the press is cylindrical, with a corresponding plunger, and therefore the cake of India rubber, when set and hard, assumes a cylindrical shape, which may be readily cut by a knife, or other cutting apparatus, into disks; or the cylindrical vessel may have a cylindrical core in the middle of it, and then the cake, when set, will be of a pipe or hollow cylindrical form, and the pieces sliced off from it will be rings.

The machinery for grinding the India rubber has teeth not much unlike other metallic mills, and by the rotation of the working parts, the material (previously heated) is so worked up as to become one mass. The press may retain the mass or material, as described, until it has become a solid compact cake; or it may be forced out on the side of the press, and passed between rollers, for the purpose of being forced into sheets, and lapped upon a roller. Under this head a machine is described in which the cylindrical block of India rubber may be cut, by means of rotary circular knives, into disks or into rings; the block of India rubber revolving slowly, whilst the circular knives turn rapidly; or the lapped sheets may be cut into tape, by a spiral action of the cutter. The patentee, however, does not appear to intend claiming the invention of any precise form of machinery, but only a convenient mechanical means of effecting the operation.

Under the third head, a machine is described for cutting threads of India rubber from the edges of a series of disks, which may be reduced into fine strands, by a drawing process, like wire: the fourth head points out the means of coiling threads of cotton, silk, or other material round the strands of India rubber; the fifth, the proposed mode of rendering fabrics waterproof; the sixth, of weaving ornamental elastic fabrics; and the seventh, of applying India rubber, in several ways, to bookbinding. But the patentee has, since inrolling his specification, found it necessary to disclaim the third, fourth, fifth, sixth, and seventh heads of his invention, as not new at the time of granting his patent.

Ibid.

Specification of a patent granted to GEORGE HERBERT JAMES, *of the city of London, wine merchant, for an improvement in making bread, being a communication from a foreigner residing abroad.*—[Sealed 23d January, 1838.]

The specification of the patentee is as follows:—In order to produce the best possible bread, viz. that which shall be most nutritive, and, at the same time, the most easy of digestion, the following conditions ought to be strictly observed, that is to say, first, that the flour used in the process should be rich in gelatine, and not charged by incipient fermentation; secondly, that the dough should be perfectly combined with the water, and not compact or close, thirdly, that the bread shall be well risen or leavened, that is to say, that the primary fermentation should have been well performed; fourth, that the bread should not be sour, and not overbaked.

Now, it has been proved that bakers do not cause the water used in making bread to combine with the flour in a proper or suitable manner, and this defect in the process renders the bread much less nourishing, and more difficult of digestion. Bread made according to the usual method does not retain a sufficient quantity of water in it, as a great portion of this fluid, so useful in digestion, evaporates by the action of the oven or furnace, by reason of its not forming an integral part of the flour; and, accordingly, the nature of this invention of an improvement in making bread, mentioned in the said letters patent granted to me, consists in previously combining with the water used in making the bread, a portion of flour of the first quality, by causing it to undergo the process of boiling or ebullition; and, in using the mixture or composition thus produced in lieu of pure water, for, by this process, the water becomes so completely combined and incorporated with the flour, that the heat of the oven will cause but a very small portion of it to evaporate, and the bread produced is of a more nutritive quality, and, at the same time, of easier digestion.

The best manner in which the said invention can be performed is, to the best of my knowledge, the following: that is to say, for one sack of flour, weighing 280 lbs., take 10 lbs. of flour, which should be of the first quality, which is to be diluted in 20 quarts of cold water; then boil in the steam caldron, which is the best utensil for the purpose, 55 to 60 quarts of pure water; and when the 55 to 60 quarts of pure water are in a perfectly boiling state, or bubbling state, add thereto, and in small quantities at a time, the diluted flour, being very careful to stir without ceasing the boiling liquid. When all the diluted flour has been so added, the boiling of the entire mixture must be so continued during a quarter of an hour at least, or, in other words, till the flour is thoroughly and completely combined with the water, forming a gelatinous size or starch. The entire mixture must then be taken off the fire, and strained through a sieve, in order to free it from any particles of flour which may have formed into lumps. By using this mixture, which has the appearance of thin starch, cooled to 75 degrees of Fahrenheit's thermometer, instead of pure water, bread of a finer appearance and lighter quality, more nourishing, and of easier digestion, will be produced, than that obtained from flour of the same quality, where the method in ordinary use with the bakers has been followed; to which may be added, that the proceeds will be more abundant, inasmuch as from 106 to 107 baked loaves, each of the weight of 4 lbs., may be produced, by this process, from the before named quantity of 290 lbs. flour.

In other respects, the bread is to be made in the usual way, except that it would be proper to add to it a rather larger portion of salt, say 12 ounces, to the hydrated flour. And I hereby declare, that my claim to the said invention of an improvement in making bread is limited to the preliminary combination of flour with water, in the manner hereinbefore described, and to the application of the diluted or hydrated flour so produced, instead of pure water, in the process of making bread. Lond. Jour.

Specification of a patent granted to WILLIAM HINCKES COX, *of Bidminster, near Bristol, tanner, for his invention of an improvement or improvements in tanning hides and skins.*—[Sealed 15th September, 1836.]

The patentee commences his specification by describing the disadvantages of the different modes of tanning at present in use, and then points out the beneficial effects which will result from the adoption of his improved method of tanning. He first informs us that the ordinary method of tanning, and that process which is now most generally in use, is by subjecting the skins or hides after they have been deprived of the hair, to a process of steeping in pits, until, by the action of the tanning liquor, the hides or skins may be considered to be sufficiently tanned, which will be readily known to any person who is conversant with this branch of manufactures.

Now, this process of tanning is one which takes a long time, generally several months, before the skins or hides are considered to be tanned sufficiently; and many schemes have been proposed and tried, by means of which the duration of this process might be considerably shortened, and even confined to a few hours. Among others, one method proposed was, by joining two skins or hides together at their edges, by means of metallic clamps or frames, and thereby forming a sort of bag, into which the tanning liquor was poured, and by hydrostatic pressure forced through the pores of the skins or hides.

This process, however, is liable to serious objections, as the effect of the pressure would be to distend and strain the skins or hides, and separate the particles of which they are composed, and by this means considerably weaken them, owing to their being supported by the metallic clamps at their outer edges only. Now, this is highly prejudicial to the object to be accomplished, it being desirable rather to condense the skins or hides than distend them; and this evil is still more seriously apparent, when there are any weak places in the skins or hides; so that the advantages which may appear to result from this process, are more than counterbalanced by the disadvantages that have been pointed out.

Since this method has been put into operation, and found to fail, from the causes hereinbefore stated, another method has been tried, which although not quite so injurious, is still liable to the same objections, viz.: the distension of the skins or hides, when the hydrostatic pressure is employed: for the plan is supporting the sides of the hides or skins by rigid bars of iron or wood with spaces between them. It was supposed that these bars would counteract any prejudicial strain which the hydrostatic pressure might occasion; but by this apparatus the skins or hides are only partially supported; those parts which are not actually in contact with the bars are consequently unsupported, and bag between the bars, which causes those parts to be distended by the pressure, whilst those which are supported by the bars are not so effectually acted upon by the tanning liquor; and although to remedy this latter evil it was proposed to shift the position of the skins

or hides so as to make the tanning liquor act equally on every part, yet no even effect could be obtained, and thus this process was rendered but very imperfect.

The Patentee now proceeds to inform us that his invention consists in fastening or sewing together two or more hides or skins, so as to make a bag to contain the tanning liquor, and supporting the sides of the hides or skins by means of fibrous materials, which, while they give the required support, yet allow the tanning liquor to ooze out or percolate through the skins and pass away, the fibrous materials being sufficiently pliant to accommodate themselves to the shape or figure of the bag or skins, without allowing one part to be subjected to a greater pressure than another.

The Patentee also states, that the material which he prefers to use, and which by experiment he has found to answer the purpose best, is a sort of coarse canvass of rather an open texture, such fabric being suitable for giving a close and equal support to every part of the bag composed of the hides or skins, and also admitting of a free passage of the liquor, and allow it to flow away after it has percolated through the pores of the hides or skins.

The improved process is thus described:—I take a skin or hide that has been previously prepared with a backward ooze, for the purpose of bringing it into a suitable condition for receiving a stronger liquor, and of giving it a good leather color. The outer edges are to be sewed together tightly with well waxed thread, for the purpose of forming a bag, a small opening being left at one end for the purpose of introducing the tanning liquor; and should any holes be discovered, they must be sowed up, when the bag will be ready to be hung up to receive the tanning liquor.

The Patentee prefers having the flesh side of the skins inwards, as more calculated to receive the tanning liquor with facility.

The hides or skins being thus made into a bag, are then suspended from two hoops in such a manner that they may hang clear from the ground; and gutters should be made beneath them for the purpose of receiving the tanning liquor, which oozes through and drops on to the ground, in order to convey it into pits or tanks made for that purpose. A covering of coarse canvass is then to be placed round each bag, in the edges of which eyelet-holes are made for a lacing string, so that the canvass bag or covering can be drawn up and laced closely round the hides, and an equal support is afforded on all sides.

The bag or skin is then to be filled with the tanning liquor, which is conveyed to it by a pipe from a tank placed in a suitable situation for that purpose; and in order to carry on the process with expedition, a suitable shed or building should be conveniently arranged for having a number of these bags hanging in a row, in such a manner that one pipe running along the extent of the shed, and supplied with suitable branch pipes, might supply the whole number of the bags, each branch pipe being supplied with a stop cock for turning on or cutting off the tanning liquor.

The branch supply pipe to each bag should be inserted into the opening at the top of the bag, and the skin tied tight round it to exclude the air; and each bag must be furnished with a stop cock at the top, which should be open while the tanning liquor is running into the bag, for the purpose of allowing the air in the bag to escape.

The supply pipe being thus inserted into the upper part of the bag, the pressure of the tanning liquor will be as the perpendicular height of the column, the liquor will percolate through the pores of the skin, and rapidly

produce its effects thereon. As the liquor oozing through the pores of the skins, with the leakage that may take place, tends to lessen the quantity of liquor in the skins, so its place will be supplied from the tank through the open supply pipe.

The time that may be allowed for completing the process will, of course, depend on the nature, thickness, and quality of the hides, and perhaps from other causes, as is generally the case in the process of tanning; but any person who is conversant with the process, will readily know when the desired result is obtained; but the operator may know with certainty what effect is produced by cutting away a small portion of the outer surface of the skin.

When the hides or skins are deemed sufficiently tanned, an aperture is made at the bottom of the bag by cutting away some of the stitches, and the tanning liquor allowed to flow out; the edges are then cut off, and the skins afterwards dried and finished in the usual way.

The Patentee says, in conclusion, "having now described the nature of my invention, and the manner of carrying the same into effect, I would remark that other materials may be employed for making the canvass covering for the bags than that above described, without departing from my invention, though I consider the material above described to answer the purpose best; therefore, I do not intend to confine myself to any particular material for covering or giving support to the hides or skins; and I would also have it understood, that I lay no claim to the forming of hides or skins into bags for the purpose of suspending them, and causing the tanning liquor to percolate through; nor do I lay any claim to giving external support to the skins, when this support is given by rigid bars or surfaces pressing on parts and leaving other parts unsupported, and by this means producing an unequal effect; but what I claim as my invention is, the application of a covering or support made of fibre, which is capable of giving an even and close support to all parts of hides or skins on one side thereof, when pressed on the other side by the tanning liquor, at the same time such cover of fibres will allow of the tanning liquor readily flowing away through it after having passed through the pores of the skins or hides, as above described." Ibid.

Specification of a Patent granted to WILLIAM NEALE CLAY, *of the county of Stafford, and* JOSEPH DENHAM SMITH, *of the borough of Southwark, for their Invention of certain Improvements in the Manufacture of Glass.*—[Sealed 16th November, 1837.]

This invention consists in the application of certain materials in the manufacture of glass, not heretofore so used, by which we are enabled to obtain various descriptions of glass of an excellent quality, and at a reduced cost; such materials being used with the matters now employed, or in substitution for some of the matters now used in the various mixtures for making glass, which is brought to market under various denominations, the names of such glass depending, in some respects, on the process through which it passes, and the uses to which it is applied; but all glass-making may shortly be stated to be the fusing of silica at a great heat, with certain saline or alkaline substances, and, in some cases, the oxides of lead at the same time. There are probably no two glass-makers engaged in making glass which is sold by the same name, who would agree as to the mixtures to be used; and, as far as our experience goes, we have not found any two

makers, either of flint glass, crown glass, plate glass, or glass under other names, who employ the same quantities of ingredients; and, in some cases, different makers vary the materials from which the same named glass is manufactured.

We are, therefore, unable to set forth any general rule of glass-making for any of the various named glasses; at the same time, the materials which we apply to the purpose of improving the glass manufacture in general, will, with greater or less advantages, apply to the various mixtures used by different glass manufacturers. We, therefore, propose to give such mixtures of silex, and the materials ordinarily in use, with such quantities of the materials now to be newly applied, according to our invention, as will be suitable to the making of flint glass.

The various processes of glass-making being well known to glass makers, no description will be required for performing the same, such processes constituting no part of our invention: nor are the processes of fusing of the mixtures, nor the subsequent treatment of the glass to produce the various named glasses, changed or altered. The invention relating to the application of certain materials not hitherto so used in combination with silex and other matters for making glass.

And our invention consists, first, in the application of combinations and salts of barium, strontium and zinc; and, secondly, in the application of granitic, or other rocks abounding with felspar.

In using combinations, or salts of barium, or of strontium, we prefer the carbonates of barytes or strontia which are found native in some parts of this kingdom; or otherwise, for them to be in the state of sulphate of barytes; in which latter case we mix a proportion of charcoal, or other carbonaceous substances.

In using combinations or salts of zinc, we prefer the oxide of zinc which is formed during the process of manufacturing that metal.

Mixture for making glass by combining combinations, or salts of barium, with silex and other materials: Sand, 320 parts by weight; red lead, 150 parts by weight; carb. barytes, 145 parts by weight; carb. potash (pearl ash,) 112 parts by weight; nitre, 7 parts by weight; some little oxide of manganese (the usual quantity.)

Mixture for making glass by combining combinations, or salts of strontium, with silex and other materials: Sand, 320 parts by weight; red lead, 150 parts by weight, carb. strontia, 108 parts by weight; carb. potash (pearl ash,) 112 parts by weight; nitre, 7 parts by weight; oxide of manganese as usual.

Mixture for making glass by combining compounds, or salts of zinc, with silex and other matters: Sand, 320 parts by weight; red lead, 150 parts by weight; oxide of zinc, 56 parts by weight; pearl ash, 112 parts by weight; nitre, 7 parts by weight; oxide of manganese, some little as usual. In some cases we do not use red lead (oxide of lead,) but then we double the quantities of carb. barytes, carb. strontia, and oxide of zinc, respectively.

Other descriptions of glass we make with the following mixtures:

	Parts by weight.
Sand - - - -	480
Carb. barytes - -	300
Carb. soda (pure)	165
Little oxide of manganese.	

	Parts by weight.
Sand - - - -	480
Carb. strontia - -	224
Carb. soda (pure)	165
Little oxide of manganese.	

	Parts by weight.
Sand - - - -	480
Oxide zinc - - -	120
Carb. soda (pure)	165
Little oxide of manganese.	

Further mixtures:

	Parts by weight.
Sand	280
Chalk	88
Sulph. soda	84
Sulph. barytes	90
Charcoal	8
Little manganese.	

	Parts by weight.
Sand	960
Chalk	200
Sulph. soda	290
Sulph. barytes	460
Charcoal	40
Little manganese.	

	Parts by weight.
Sand	960
Chalk	200
Sulph. soda	290
Sulph. strontia	370
Charcoal	40
Little manganese.	

These mixtures form cheaper glasses, as they enable the manufacturer to use less alkaline or saline substances than before.

We will proceed to give mixtures of the application of those rocks in which felspar predominates, and which, at the same time, contain very little or no oxide of iron; as, for instance, a mineral found in Cornwall, and used in the potteries under the name of "Cornish Stone;" this we use in conjunction with common salt or muriate of potash, and we find these mixtures to afford good and cheap glass.

	Parts by weight.
Cornish stone powdered fine as sand	100
Common salt	12
or	
Muriate of potash	16
Chalk	20

	Parts by weight.
Cornish stone powdered fine as sand	100
Common salt	16
or	
Muriate of potash	22
Chalk	16

Having thus described the nature of our invention, and the manner in which the same is to be performed, we would remark, that although we have given particular quantities of the various materials in the mixture, we do not confine ourselves thereto, and the glass manufacturer will readily adapt our invention to the object he desires: for, it will be seen that an important feature of our invention is, in some cases, to reduce the necessity of using so much red lead, and, in other cases, to dispense with the use of red lead altogether, and, in other cases, to reduce the extent of using alkaline or saline substances, by the application of other materials. Hence, supposing a glass-maker is about to apply any of the substances herein mentioned, as constituting our improvements in the manufacture of glass, and supposing him to have a particular mixture of his own, which, as before stated, is most generally the case, he will apply some one or more of the matters herein mentioned, for it is not necessary that only one of the matters should be employed in any particular mixture.

And we would have it understood that we lay no claim to the using of any of the other materials herein described, nor do we confine ourselves thereto, as there are other materials used in glass-making, for various purposes, and as is well understood. But what we claim, as the first part of our invention, is, the application of compounds, or salts of barium, strontium, and zinc, in combination with silica and other materials, in the manufacture of glass; and, secondly, we claim the application of granitic or other rocks in which felspar predominates, in the manufacture of glass.—

Percussion Tubes for Cannon. *By* JAMES MARSH, *of the Royal Arsenal at Woolwich.*

Mr. Marsh's invention is peculiarly adapted to ships' guns, and consists of two distinct improvements, one relating to the tube, and the other to the explosive composition with which the tube is filled.

In those ships' guns which are discharged by means of a common flint lock, a cord (in sea phrase a lanyard) is fastened to the trigger, in order that the gunner, while standing clear of the recoil, may be able to fire it at the instant that the object aimed at comes in a line with the sights; for, as both the antagonist ships are in a state of motion, it is evident that the least delay will, in all probability, occasion the mark to be missed. In adapting percussion powder to the discharge of cannon, the lock was entirely removed, and replaced by a hammer moving on a pivot, which, being first brought into position merely by throwing it back, is then, by pulling steadily and without jerk at the lanyard, made to descend with considerable force, striking the gun about half an inch short of the touch hole. A quill, charged with meal gunpowder, was thrust into the touch hole, having a short lateral pipe of thin sheet copper attached to it at right angles near the upper end: this pipe was charged with percussion powder, and care was taken, in putting the quill into the touch hole, that the pipe should project directly over the place where the hammer would fall; it thus received a blow which caused the percussion powder to explode, and this, setting fire to the meal powder in the quill, discharged the gun.

To this plan there were two objections; one, that the gun often missed fire; for, although percussion powder is easily exploded by a sharp blow, yet a heavy slow one often fails to produce the desired effect, and it is difficult to give the hammer sufficient rapidity of descent by pulling at the lanyard. The other objection is, that the force of the explosion projects the copper tube with so much violence as to wound the people standing near.

The latter of these objections Mr. Marsh has removed by substituting the barrel of a crow quill for the copper tube, and the former in the following way:—

The common composition for percussion powder is the same as that used for the lucifer matches, viz. equal parts of sulphuret of antimony and of chlorate of potash. These ingredients are separately rubbed to fine powder, and then mixed intimately by running them through a fine sieve, and are then made into a paste by thin starch or gum water. It is well known that gunpowder itself, and many other explosive compounds, will bear any degree of dead pressure, and may even be rubbed in a mortar without exploding, but the presence of a few grains of sand, or any other hard, gritty substance, with even moderate friction, will occasion immediate explosion; on which account, the common lucifer matches, when drawn smartly through a piece of folded sand paper instantly take fire. Mr. Marsh, proceeding on this principle, mixes with the ingredients already described, half their weight of finely pounded green glass. There is also novelty and good sense in the manner in which he charges the quill. He first moistens the meal powder with a mixture of thin gum water and alcohol, and then rams it into the main barrel of the quill, and charges the lateral one in like manner, with the percussion powder slightly moistened. After the whole has become dry, he

introduces a piercer up the middle of the larger barrel, and a smaller one up that of the lateral barrel, thus forming a connected tube from the outer end of the lateral barrel to that of the other. The consequence of this is, that when the hammer falls the percussion powder instantly explodes, sending a flash through the middle of the gunpowder, and setting fire to that likewise. The flame of the gunpowder, meeting with no resistance to its descent, rushes through the perforation and instantly fires the gun. The effect of this arrangement was shown by an actual experiment on the model of the breech of a gun before the committee. A charged quill was put into the touch hole, and a metal pipe was screwed to the bottom of the touch hole, making the entire length, from the quill to the end of the pipe, at least two feet. About half an ounce of gunpowder, tied up in a piece of the same kind of thick woolen cloth as common cartridges for cannon are actually made of, was laid on a board just beneath the end of the tube, and, on pulling the lanyard, the contents of the priming quill exploded, and a body of flame darted down the metal tube, pierced through the woolen cloth, and set fire to the gunpowder wrapped up in it.

Mr. Marsh's priming quills have been tried, by order of the Board of Admiralty, on board the Excellent, the experimental ship at Portsmouth, with entire success, there not being a single missed fire in 900 rounds. In consequence of which the Admiralty have made him a pecuniary present, and have already adopted its use in many of the ships of war now in commission.

Mr. H. Wilkinson, one of the committee, stated, that he has made comparative experiments with percussion powder, made of chlorate of potash and sulphuret of antimony, and Mr. Marsh's composition, and finds that the former requires a far sharper blow to cause it to explode than Mr. Marsh's does: he has also ascertained that neither fulminating mercury, nor even fulminating silver, alone, are so easily exploded as Mr. Marsh's powder is.

Trans. Society of Arts.

Silk, raw and manufactured, from Lower Assam.

The Society of Arts have received from the Agricultural and horticultural Society of India, some specimens of silk, both raw and manufactured, sent to them by Captain Francis Jenkins, agent to the Governor General on the N. E. frontiers of Bengal. They are from the neighbourhood of Gowahatty, in Lower Assam, and are the produce of two species of caterpillars, different from that which produces the true silk.

One of them is called "the worm of the moonghatree." Of the silk of this insect, two samples in the raw state, that is, merely wound off the cocoon, have been received, and two plain cloths manufactured in Assam from the same silk.

Both the samples of raw silk have considerable lustre, and have a reddish cast of colour. One of them is too coarse for ordinary use, but appears likely to be valuable for sewing silk, for which there is always a large demand, and, the sample being more than usually clean for so full a size, it would, probably, meet with a ready sale, if reeled from the cocoon in large skins. The other sample is similar to, but of better quality than, the former.

Of the two cloths manufactured from this silk, one bears a resemblance to Indian taffeta, and the other to China crape. From the state in which

the Society received them, it was evident they had undergone no process of bleaching or softening; the committee, therefore, directed that a square of each should be well boiled in soap and water for several hours. This was done, and the cloths were considerably improved in softness, colour, and lustre; the colour, however, still remained similar to that of pale nankeen, and the lustre inferior to that of true silk. The above samples, both raw and boiled, having been shewn to a silk manufacturer in Macclesfield, were recognized by him as being exceedingly like some which had come into his hands under the name of *jungle silk*, and which, when treated in the usual manner, was found to be too deficient in colour and lustre to answer as a substitute to similar fabrics made of true silk.

The other kind of silk is called by Captain Jenkins Area silk, and the insect which yields it feeds on the leaf of the castor oil plant (Ricinus communis,) and, in case of necessity, it will feed also on the leaves of the Kaura, (Sapium sebiferum) and of the Jetropha manihot. Captain Jenkins farther says, that it is twisted, by hand, into coarse thread, of which are made large heavy blankets, which are almost indestructible, descending, literally, in constant wear, from father to son. He farther states, that the samples sent, being new, give no adequate idea of the degree of softness to which it is brought by long wear and frequent washing.

Of the Area thread two varieties have been received, one of a dirty white colour, and the other of a yellowish brown; the latter being considerably harsher than the former, though superior to it in lustre. The thread is composed of very fine filaments, each individually having considerable lustre; but as they have evidently been made into thread, not by winding from the cocoon, but by spinning by hand, probably after being coarsely carded, the lustre of the thread, as well as of articles made from it, can scarcely be greater than that of *spun silk*. The thread, besides, is as ill made and uneven as possible, and very dirty, no doubt from the manner in which it is made, being merely twisted by rolling it between the hand and the thigh.

The Area silk seems greatly to resemble a kind described by Dr. Roxburgh in vol. vii. of the Linnæan Transactions, by the name of Arindy silk, produced by the Phalæna cynthia, and which he says, is cultivated in Bengal, in the districts of Dinagepour and Runghpour: its cocoons are either white or yellowish brown; and the filament is so fine that the natives do not attempt to reel it, but pull it off the cocoon and spin it like cotton.

A square of each of the cloths of Area silk was boiled in soap and water: much dirt was extracted, the colour was improved, though still it was far from white; and though the fringed or ravelled edges had more or less of a silken lustre, yet the coarser of the two cloths still remained as dull as nankeen, which it considerably resembles; whereas the other, which is of a lighter and looser texture, is by far the softer of the two, and shews some lustre, which repeated washings would probably increase. Ibid.

ARTICLES FROM THE FRENCH JOURNALS. TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE, BY J. GRISCOM.

Caramel.

When common sugar is heated to the temperature of 210 to 220° Cent. and maintained at that degree of heat, (which may be easily done by means of an oil bath,) it swells, and a strong, and as it were, spontaneous reaction takes place among its elements; the sugar acquires a brown tint, which be-

comes more and more dark. *Not the smallest quantity of permanent gases escapes from it,* but much watery vapour is disengaged, which, when condensed, exhibits traces of acetic acid, and an oily matter which exhales, faintly, the odour of burnt sugar.

When the swelling has ceased, there is found in the retort a black substance, having the brilliant aspect of anthracite. It is entirely soluble in water, and the solution has the rich tint of the sepia, and retains none of the sweet taste of the sugar. It is as insipid as gum arabic, and shews not the least sign of fermentation under the action of yeast. Such are the characters of this substance in a state of purity, and though it may not be immediately obtained in this state, it may be procured by treating the contents of the retort once or twice with alcohol, after having dissolved it in a very small quantity of water. If sugar remains, the alcohol dissolves it as well as an accidental substance which occasions the peculiar bitterness of burnt sugar. The product being insoluble in alcohol, is precipitated.

The substance now in question having some analogy to the caramel of the shops, which is a mixture of sugar with this substance itself, I give it the name of *caramel,* to avoid the embarrassment of a new term.

Caramel, dried at 180° Cent., has appeared to me of uniform composition. Its analysis is accomplished with much difficulty. As it does not melt, it has a tendency to leave a residuum of charcoal of extremely difficult combustion. I obtained the following results:—

	(1)	(2)	(3)	(4)
Carbon	46.6	46.	47.56	46.9
Hydrogen	6.1	6.1	6.2	6.3

These numbers agree with the formulæ.

C^{48}	1836.4	47.5
H^{36}	224.6	5.9
O^{18}	1800.0	46.6
	3861.0	100.0

It will be observed that caramel, like sugar, contains hydrogen and oxygen in the proportions which constitute water; and also, that to be transformed into this product, the sugar loses four atoms of water, which is confirmed also by direct experiment. Caramel therefore, has the composition of anhydrous sugar, as it exists combined with the oxide of lead.* It is impossible to conceive of a more simple decomposition.

Sugar of starch, of diabetes, and of grapes, subjected in the same way to the action of heat, is transformed into a product identical with the caramel procured from common sugar. A greater quantity of water, however, is disengaged, and the operation is more difficult, on account of the great ebullition which takes place during the decomposition.

Caramel acts the part of a weak acid; it precipitates the ammoniacal acetate of lead very abundantly; it forms with barytic water, a voluminous precipitate, which does not dissolve, even in warm water, and which contains, as I have found, 20 to 21 per cent. of barytes.

It sometimes happens, that in the preparation of caramel, the heat becomes so great, or its action is so prolonged, that the body is decom-

* This the author had established in a preceding part of his elaborate memoir on the nature and chemical properties of Sugars. Ann. de Chim. et de Phys. tom. lxxvii. p. 124.—Trans.

posed, by simply losing an additional portion of water. The substance which remains is not soluble, and may be easily separated from caramel itself. It contains hydrogen and oxygen in the same proportions as the products from which it is derived. If, in short, the heat be continued sufficiently, the combustible elements react on each other, and the ultimate decomposition is effected, which is the only kind that had, until the present time, been observed.

It is very probable that the greater number of substances, which in composition are analogous to sugars, would furnish, at a suitable heat, substances like that we have now described. A study of this kind, directed for example to lignite, might easily lead to an explanation of the formation of the acetic acid which the decomposition of wood yields in variable quantity, dependent on the manner in which the distillation is regulated.

EUGENE PELIGOT. Ann. de Chim. et de Phys. Feb. 1838.

Composition of Resin.

The March number (1838) contains an interesting memoir of more than 30 pages, on the "*Chemical examination of the products arising from the employment of Resin for the purpose of Gas Illumination.*" By M. M. PELLETIER and PHILIPPE WALTER.

The results of this investigation, as summed up by the authors themselves, are thus stated,—

"It follows from what precedes,

1st. That at the moment when resin falls into a cylinder at a bright red heat, as is practised at the gas works, there is formed, concurrently with the illuminating gas, and with carbonic and acetic acid, a great number of very hydrogenated products, which we have succeeded in separating by the means which analytic chemistry now furnishes.

2d. That among these substances are three new kinds of carburetted hydrogen which we have described under the names of *retinapthe*, *retinyle*, and *retinole*, and two *solid carburets of hydrogen*, naphtaline, already known, and metanaphtaline, a new substance.

3d. That retinaphte is a very light, volatile liquid, whose composition, determined by analysis, may be represented by $C^{8}\ H^{16}$, which renders it at least isomeric with a carbonated hydrogen, still hypothetical, which appears to act an extensive part in benzoic compounds, if it be not this hydrogenated substance, (s'il n'est cet hydrogéni,) which itself gives rise to a series of new compounds, several of which are described in the memoir.

4th. That retinyle is a new sesquicarburet of hydrogen, which may be represented by the formula $C^{9}\ H^{6}$ or ($C^{36}\ A^{24}$,) susceptible also of being transformed by chlorine, bromine, nitric acid, &c., into compounds which also present a series of new combinations.

5th. That retinole is a new bicarburet of hydrogen, of the formula $C^{16}\ H^{8}$ or ($C^{64}\ H^{32}$,) different from the bicarburet of hydrogen $C^{6}\ H^{3}$ of Faraday, both in constitution and chemical properties.

6th. That metanaphtaline is a new substance, different from naphtaline in its properties, but isomeric with it in composition; a substance remarkable for its beauty, and its chemical inertness, a property which assimilates it to paraffine, but from which it totally differs in physical properties and composition.

In this memoir we have shown the nature, properties and composition of

the substances which result from a red heat applied rapidly and in a manner instantaneously, to resin. In a second, we propose to examine the products arising from resin at lower temperatures.

Recurring to the present results, we shall inquire into the action of heat more or less suddenly applied to our products, to ascertain whether they pass into each other. We may thereby learn some facts which may serve at a future period to establish the theory of *pyrogenous products*,—a theory which latterly has made such great progress in the hands of two of our ablest chemists; but which it would be very unreasonable, in our opinion, to regard as definitively settled. Ann. de Chimie, et de Physique.

Ferment, or Yeast, its Nature.

This substance has recently claimed the attention of several chemists, who have examined its properties, the manner in which it is affected by various agents, and the changes it produces on them.

M. Cagnard-Latour (Comptes rendus de l'Institut, 1837, page 906,) thus sums up the results detailed in his memoir:—

1st. The yeast or leaven of beer is a mass of small globular bodies, capable of self-reproduction, and of course oxygenized, and not an inert or purely chemical substance, as has been supposed.

2d. These bodies appear to belong to the vegetable kingdom, and are generated in two different modes.

3d. They appear to act upon a solution of sugar as if they were alive, whence it may be inferred, that it is in all probability by some effect of their vegetation that they disengage carbonic acid from this solution, and thus convert it into a spirituous liquor.

I will further observe, adds Cagnard-Latour, that yeast, considered as an organized substance, deserves perhaps the attention of physiologists as such; for

1st. It springs forth and developes itself, in certain circumstances, with great rapidity, even in the midst of carbonic acid, as in a brewer's vat.

2d. That its mode of regeneration presents peculiarities of a kind which have not been observed with respect to other microscopic products, composed of isolated globules.

3d. And that it does not perish by a great privation of heat or of water.

M. Desmazieres, as long ago as 1826, describes and figures the globules of yeast, with so much precision as to require but slight modifications to render them equal to what is now known, but it is very extraordinary that he seems never to have suspected the part which these globules act in the process of fermentation.

In a valuable memoir by T. A. Quevenne on this interesting subject, (Jour. de Pharm., Juilliet, 1838,) the author arrives at the following conclusions:—

1st. Yeast is a substance which constantly presents the appearance of little globules of nearly uniform figures.

2. These globules appear to be always of the same nature, whatever their origin.

3d. It is the insoluble constituent part of these globules which is apt to produce fermentation, and not the extractive matters which accompany it.

4th. The globules of yeast can effect the decomposition of sugar not only at a temperature from 10° to 30° or 40° Cent., but even at the heat of

boiling water; but, with this differenee, that at a temperature inferior to 50° they transform the sugar into alcohol and carbonic acid, while above 50° (= 122 F.) alcohol appears not to be formed;—the only gas obtained in either case is carbonic acid.

5th. Yeast, during the alcoholization of sugar, undergoes a thorough modification. It loses all its azote, which goes to form ammonia, by which means its fermentative power is completely exhausted.

6th. The globular aspect of yeast, and its principal chemical properties, are sufficient to induce us to regard it as an organic substance of new formation; and hence fermentation ought not to be considered merely as a decomposition, but simply as a modification which gives birth at one and the same time to products both organic and inorganic.

7th. The circumstances under which fermentation takes place, and the phenomena which accompany it, and the influence which a great number of bodies have over the progress of the operation, are of a nature to induce the belief that it is actually owing to a sort of vegetation; but this proposition, before it is definitively admitted, appears to me to require additional proof.

Jour. de Pharm.

Simple method of depriving the common Oil of Petroleum completely of its color, without distillation. *By* Böttger.

Add to two pounds of common oil of petroleum, in a glass vessel, from four to six ounces of fuming sulphuric acid. Shake the mixture several times a day during several days. In about a week the oil will be colorless, and all organic matters which it contained will have been carbonized by the sulphuric acid.

Open the bottle, and taking care to avoid the sulphurous acid gas which rapidly escapes, draw off, by a syphon, the oil into another bottle, add some water and shake it well, renewing the water several times. Let it remain at rest for some time, and then draw it off into a third bottle into which about three ounces of caustic lime, in fragments, has been put. Shake it again repeatedly, and then let it remain at rest for some time. The oil purified by this method is perfectly colorless, and very fit for the preservation of sodium and potassium, which will remain for years in it without oxidation.

This method was tried by F. Möhr, and succeeded perfectly. A. G. V.

Idem.

Filtering Apparatus.

The method of Fonvielle (V. Jour. Frank. Insti., vol. xxii,) continues to operate in the most satisfactory manner. On the 2d of June last a large assembly of high municipal and other functionaries, with many savans and other citizens, attended at the pump of Notre-Dame to witness the operation of the filtering machine. A single box, gauged in the presence of the audience, and whose capacity did not exceed one metre by two, operating under a pressure of 45 feet head, yielded, per minute, 280 litres (= 74 galls.,) of filtered water, or 106,560 gallons per day. An apparatus on the old construction, would yield only about the eight hundredth part of this quantity.

The facility with which these filters clean themselves, interested the company very highly. It is this indeed which gives the highest additional value to this important invention. To witness the extreme filthi-

ness of the water driven from the apparatus by the shock of the two opposite currents, and this in a few moments after succeeded by perfectly limpid water, gave universal satisfaction.

The filtered water, though issuing from the filtering box situated in the lower part of the building, is, by an arrangement now first introduced by the company, made to ascend, by hydrostatic power, to a height nearly equal to that of the head, and thus, at pleasure, it can be distributed to all parts of the edifice where it may be wanted. Rec. de la Soc. Polytechnique.

Method of Perforating Glass. By M. Albrecht.

Put a drop of spirits of turpentine on the place where the hole is to be made, and in the middle of this drop a small piece of camphor. The hole can then be made without difficulty by means of a well tempered borer or a triangular file. Solid turpentine answers as well as a mixture of the oil or spirit and camphor. Annales des Mines.

Researches on Filtering Paper. By Werdemiller de Elgg.

The filtering paper I use in my laboratory, leaves by combustion, 0.006535 of ashes, composed of

Sand	0.0225
Silica	0.2868
Alumine	0.1222
Peroxide of Iron	0.0781
Lime	0.3421
Magnesia	1.1511
	1.0028

After being long digested in dilute muriatic acid, it leaves only 0.00171 of ashes consisting of pure silica. Treated, on the contrary, with caustic potash and then well washed, it leaves 0.00477 of ashes. Finally, treated alternately by acid and caustic alkali, it gives only 0.0005 of ashes, consisting for the most part of small grains of quartz.

When I have to weigh a precipitate collected on a filter, I proceed as follows:

I dry a filter, with the greatest care, weigh it, and preserve it wrapped up in a sheet of paper to preserve it effectually from dust. Then when I wish to weigh a common filter, I do not take the trouble to dry it, which is a tedious process, but I weigh it as it is, and then weigh my specimen filter; calculate the quantity of hygrometric water the latter has absorbed, and from these data determine what would be the weight of the filter to be employed, if perfectly dry. Ibid.

On some Phenomena of Coloration. By M. Suckow.

A bundle of four cotton wicks of equal size, moistened, one with an alcoholic solution of chloride of calcium, the second with a solution of chloride of strontian, the third with a solution of chloride of copper, and the fourth with a solution of chloride of cobalt, burns with a flame which has the same color as that of common alcohol.

A pearl of phosphate of soda, feebly colored by oxide of manganese, be-

comes colorless and transparent by the addition of a very small quantity of oxide of copper.

A pearl of the same fusion, colored yellow by the oxide of uranium, becomes colorless and transparent by the addition of a very small quantity of oxide of manganese.

A pearl of borax, colored pale blue by oxide of cobalt, becomes colorless and transparent by the addition of a small quantity of tartaric acid.

A crystal of tourmaline, one side of which was a violet red and the other colorless, was found to contain protoxide of manganese in all its parts, while the colorless portion alone contained, in addition, protoxide of iron. Ibid.

On the Condensation of Chlorine. By M. Mohr.

Melt some bisulphate of potash, pulverize it and mix it intimately with chloride of sodium and peroxide of manganese. Fill, with the mixture, three-fourths of the long branch of a very strong glass tube; press on the mixture chloride of calcium to the depth of about two inches, then close the other extremity of the tube hermetically by the lamp. Introduce this tube into a gun barrel, with sand, and heat it in a furnace adapted to organic analysis. There is soon condensed in the short branch of the tube a considerable quantity of chlorine, perfectly dry, characterized by its orange yellow color, without any shade of green. Ibid.

On the Theory of Acetification. By M. Liebig.

The process now employed in making vinegar consists in bringing into contact with atmospheric air at a temperature of 82° to 86° cent. weak alcohol, which is spread over an extensive surface by mechanical means. Under these circumstances, and by aid of the presence of a very small quantity of organic matter, (sugar, malt, &c.,) whose action has not been sufficiently studied, the alcohol is transformed into acetic acid.

The composition of alcohol is expressed by the formula $C^4 H^{10} O + Aq.$—that of acetic acid by $C^4 H^6 O^3 + Aq.$—the latter contains 4 atoms of hydrogen less and 2 atoms of oxygen more than alcohol. The subtraction of the hydrogen is effected by the oxygen of the air; 2 atoms of this gas carry off four atoms of hydrogen, and 2 other atoms unite with what remains to form acetic acid. At first *aldehyde* is produced $C^4 H^6 O + Aq.$, and the latter, in contact with the air, is oxidized with extraordinary rapidity and changed into acetic acid.

One hundred parts of alcohol take from the air 69 parts of oxygen, and make 169 parts of acetic acid, one ounce of which saturates 424 grains of carbonate of potash. With a suitable use of *mother* of vinegar, we may obtain from 63 measures of brandy having 0.150 of alcohol, 560 measures of vinegar, of which one ounce will saturate 30 grains of carbonate of potash, and there is lost $\frac{1}{13}$ of acid.

To obtain a maximum of production in the fabrication of vinegar, it is necessary to establish in the building a current of air from bottom to top, so as to furnish sufficient oxygen for the alcohol to absorb.

When there is a deficiency of air, the acetification goes on slowly and with actual loss, because a part of the aldehyde, first formed, passes off in vapor, by its great volatility, (it boils at 22° cent.,) and is not converted into

acid. In fact, by distilling a spiritous liquor incompletely changed to vinegar, a colorless fluid is obtained, in which aldehyde may be detected.

We may be certified of the presence of this substance in two ways: 1st. By heating the liquor with a solution of caustic potash, when it becomes of a wine color, yellow, brownish yellow, brown, and deep brown, according to the proportion of aldehyde. 2d. In heating it with nitrate of silver with the addition of a little ammonia;—the sides of the vessel become coated as with a polished surface of pure metallic silver. The first test is certain, and preferable to the second. Ibid.

Observations on Cane Sugar, and on a new Acid formed by the action of Alkalies on the Sugar of Starch. By M. Peligot.

It is well known that there are two distinct varieties of sugar, namely, common sugar extracted from the cane, from beets and from the maple;—and the sugar of grapes, which is also found in diabetic urine, and is likewise produced when starch, woody fibre, or sugar of milk is placed in contact with dilute sulphuric acid.

Common sugar combines with bases without undergoing any modification; for in decomposing the saccharates by weak acids, the sugar is reproduced with all its characteristic properties. It is quite otherwise with starch sugar. The alkalies and alkaline earths transform it even in the cold, into a powerful acid, which completely neutralizes bases, and which can be extracted from the insoluble combination which it forms with the oxide of lead, and into another non-volatile substance, which possesses the property of reducing immediately the salts of mercury and silver without heat. Ibid.

Elementary Composition of the Starch of various Plants; of its most concrete portions, of those most easily disintegrated, of the products of its dissolution, and the atomic weight of Starch and Dextrine. By M. Payen.

It is known that under the influence of acids, of diastase, and even by the application of heat alone, starch is converted into a gummy product called *dextrine*. Dextrine may be obtained in combination with the oxide of lead in two proportions. The basic dextrinate is procured by pouring a solution of dextrine into acetate of lead mixed with ammonia, and the neutral dextrinate by pouring acetate of lead into a boiling hot solution of ammoniacal dextrine. The two salts dried, at 100° C., contain an atom of water, which they lose at 180°. The dextrine of the dried salts is anhydrous. Its formula is $C^{24}\ H^{18}\ O^{9}$. Dextrine, in a free state, dried at 120° contains one atom of water, and dried at the common temperature it contains two atoms.

Starch has exactly the same composition and the same atomic weight as dextrine. Dried at the temperature of 130°, its formula is $C^{24}\ H^{18}\ O^{9}$, $H^{2}\ O$. Exposed to the air, dry or moist, it re-combines with different portions of water, and in its combination with the oxide of lead, heated to 100° it becomes $C^{24}\ H^{18}\ O^{9}$.

Dextrine differs from starch only in not forming a blue compound with iodine, as starch does. It appears to be nothing more than starch brought to a state of extreme division. Starch is an organic substance organized. Whatever its origin, it has always the same composition. Rubbed with

cold water, it is divided into products differing by their aggregation, but identical in their fundamental properties. Ibid.

New Method of Working Caoutchouc.

The employment of ether, spirits of turpentine, the volatile oil of caoutchouc, balsam of copaiva, and the oils obtained from gas works, as solvents of India Rubber, have the disadvantage of being expensive, and of producing a varnish which dries with much difficulty. For some time past ammonia has been used with advantage. The gum elastic, cut up into shreds, is covered with caustic ammonia and left in this state several months. The ammonia becomes brown, and the gum assumes a brilliant and silky appearance, resembling a fresh nerve. The caoutchouc swells, but is still elastic, and resembles very closely, beautiful silky threads, when drawn out, but it breaks more easily than raw caoutchouc.

In treating this swelled caoutchouc with spirits of turpentine, it is easily converted, by agitation, into an emulsion, and in a short time it swims on the surface like butter on milk; after this it acts like varnish. But a much smaller quantity of spirits of turpentine is sufficient to dissolve it than when it has not been softened by ammonia. Ibid.

On the use of Chromate of Lead in the Analysis of Organic Bodies. By M. Richardson.

This salt is prepared by precipitating a salt of lead by bichromate of potash. Heat it till it melts and then pulverize it. As it attracts no moisture from the air, it is preferable to the oxide of copper in organic analyses, for it is only necessary to keep it for a while in a warm place. The mixture must be thorough, because, for tubes of equal length, a greater quantity of the organic substance must be exposed to heat than when oxide of copper is used, on account of the great quantity of oxygen contained in the chromate of lead. Tubes for analyses ought to be about ten inches long and four-tenths of an inch in diameter.

Chromate of lead allows of a larger quantity of a substance to be subjected to analysis than oxide of copper, on account of its greater density. During the whole of the combustion, oxygen is discharged from the end of the tube containing the potash, because the chromate has a great tendency to pass to the condition of a basic salt. This circumstance, and especially the quantity of oxygen in this salt, might render it very useful in the burning of bodies which contain much carbon. This chromate furnishes also an excellent method of analysing compounds which contain chlorine, bromine, &c., because the chlorites, bromites, &c. of lead, are not volatile. Idem.

Crystals of Insoluble Substances formed Artificially. By M. Gaudin.

Microscopic crystals of a perfect form may be obtained by placing certain solutions in an artificial atmosphere; by placing, for example, a capsule containing moistened carbonate of ammonia under the same bell glass with a vessel holding a weak solution of a salt of lime, barytes, lead, &c.—or preferably, by putting into a tube, of the length of the finger, a saline solution, and over it, in the upper part of the tube, before closing it, cotton moistened with the substance intended to form the atmosphere.

To obtain crystals composed of elements scarcely or not at all volatile, we may have recourse to stratagem. Sulphate of barytes, for instance, may be formed by placing under the same glass, a vessel of fuming hydrochloric acid, and a foot glass holding water, sulphate of lime, and carbonate of barytes.

A solution of a salt of pure lime generally affords crystals under the form of primitive rhombohedrons with their principal modifications, while solutions of arragonite furnish simultaneously crystals of the form of iceland spar, and other crystals of the form of carbonate of barytes. Idem.

On the Employment of Metallic Sulphurets, prepared in the moist way, in Chemical Analysis. By M. Anthon.

Certain oxides, as is well known, have the property of precipitating others from their solutions. The metallic sulphurets prepared in the moist way, produce the same effect: the precipitated oxide is then transformed into a sulphuret, while the metal of the sulphuret combines, in the state of oxide, with the acid of the dissolved salt.

It results from the experiments that I have made with regard to silver, copper, lead, calcium, iron, nickel, cobalt and manganese, that when these metals are arranged in the above order, the sulphuret of one of them precipitates the solutions of all the metals which precede it, and occasions, on the contrary, no change in the solutions of the metals which follow. Thus the sulphuret of nickel precipitates the salts of silver, copper, lead, cadmium, and iron, and does not affect the solutions of cobalt and manganese.

There is one exception, however, and only one: the sulphuret of iron precipitates nitrate of lead, while the hydrochlorate and nitrate of the peroxide of iron are partially precipitated by the sulphuret of lead. Idem.

On the Preparation of some Amalgams. By Böttger.

I have succeeded in preparing a certain number of amalgams which hitherto had resisted my efforts. For this purpose I decompose the metallic chlorides by an amalgam of sodium. Hydrogen is disengaged, a hydrated metallic oxide is abundantly precipitated, and the mercury, which was united with the sodium, is now found allied with a certain quantity of the metal. The amalgams I have prepared by this process are those of nickel, cobalt, manganese and iridium.

The amalgams of nickel and cobalt have but little consistency; they do not act upon the magnetic needle, but the action becomes sensible when they are heated so as to expel a portion of the mercury. When the mercury is all volatilized by heat, a black very magnetic mass remains, composed of metal and oxide. The amalgam of manganese is much thicker—it is strongly charged with manganese, and it decomposes water slowly. The amalgam of iridium is prepared by decomposing a solution of the double chloride of iridium and sodium by the amalgam of sodium. This amalgam is thick enough; heat separates from it metallic iridium.

I have tried the same reaction on concentrated solutions of the chlorides of tellurium, aluminium, cerium, calcium, and nitrate of uranium, but have not succeeded in obtaining amalgams. Idem.

Physical Science.

Description and Use of a Dipping Needle Deflector, invented by Robert Were Fox, Esq. *By* Mr. T. B. Jordan, *Philosophical Instrument Maker, Falmouth.*

The data for the accompanying paper having been kindly furnished by Mr. Fox, I now have the pleasure of forwarding it for insertion in your valuable Annals, in connexion with the description of the instrument which I have already sent you.

T. B. Jordan.

Description of the Instrument.

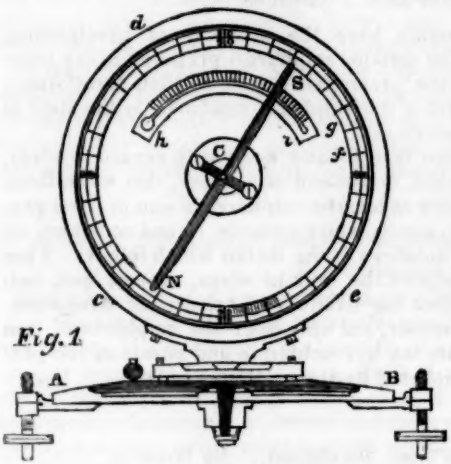


Fig. 1

Figs. 1 and 2 are front and back elevations of the instrument, and fig. 3, a transverse section with the deflectors screwed in. The same letters of reference are used in each figure. A, B, is the azimuth plate on which the vernier plate turns either in the same plane or with the usual beveled edge, as in theodolites. In the best instruments this limb is divided on silver or platina, and is read off by two verniers. The vernier plate is furnished with two levels, and the leveling screws are fixed to the foundation plate,

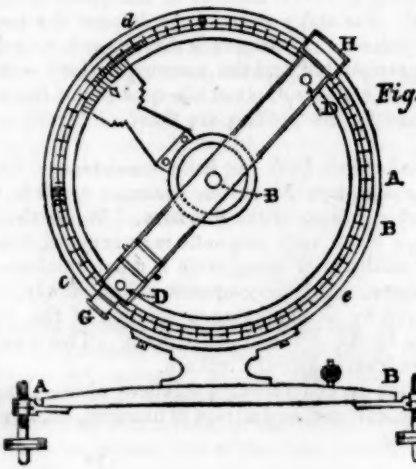


Fig. 2

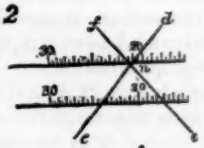


Fig. 2'

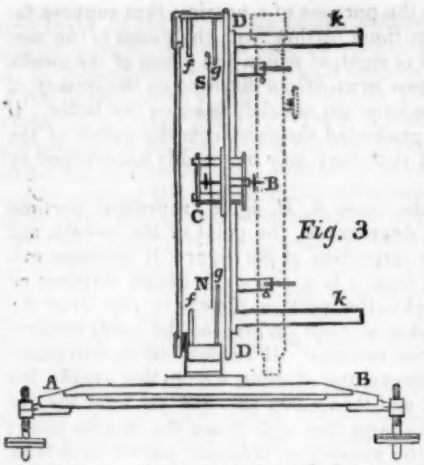


Fig. 3

as in the figures; or the instrument is made to screw on a stand similar to that used for field theodolites. *c*, *d*, *e*, is a circular brass box containing the needle N, S, two graduated circles *f*, *g*, and a thermometer *h*, *i*. The axis of the needle is terminated by exceedingly fine and short cylindrical pivots which work in jewelled holes. It may readily be removed from its bearings by releasing the screw B, at the back of the instrument, which admits of the front jewel coming forward sufficiently to remove the needle. The small grooved wheel C, on the axis, is intended to receive a thread of unspun silk, furnished with hooks for hanging the weights on in taking intensity observations, and the thermometer *h*, *i*, is intended to note the temperature at the same time.

The graduated circles, *f* and *g*, are adjusted to a perfect coincidence: the front one serves to direct the line of vision, and answers the purpose of a vernier.

At the back of the instrument (Fig. 2) there is another graduated circle adjusted to coincide with those in the box: but the zeros are generally placed on the vertical instead of the horizontal line, for the convenience of having the vernier arm independent of those carrying the deflectors.

The deflectors, *k*, *k'*, fig. 3, are two small cylindrical magnets, having their poles terminated by cones. After being magnetized and reduced to a standard intensity by heat, they are carefully packed in brass tubes; the outer tube of each is furnished with a screw, by which it can be fixed to the arms, D or D', at pleasure.

G, H, fig. 2, is an acromatic telescope fitted with webs, similar to a transit. Its use is to determine the true meridian for the variation of the needle; but as it has a vertical movement about the centre of the needle box, and a horizontal one on the vertical axis of the instrument, of course it may be used for measuring angles in either direction. It may be removed from its Ys when not in use.

The whole instrument is packed in a neat mahogany case, with magnetic armature, arranged so as to preserve the power of the different magnets. In addition to the parts described, the box contains a set of decimal weights for intensities, a pair of plyers, a rubber for producing friction on the back screw or pin, a screw driver, &c. &c.

The dotted lines in fig. 3 show the place of the telescope when in use.

Use of the Instrument.

Reading off, by means of two parallel graduated Circles.

The graduations on the parallel circles being coincident, they serve to direct the line of sight, and to prevent parallax in determining the position of the needle.

This arrangement also answers the purpose of a *vernier:* thus suppose the outer graduated circle to be *fifteen times* further from the points of the needle than the inner circle, the lines of sight, of which the points of the needle form the respective pivots, must pass over *fifteen* divisions on the former, to cause the needle to appear to pass over *one* equal division on the latter. If the relative distances of the two graduated surfaces from the points of the needle are unknown, it is evident that they may be readily ascertained by the same method.

To make this more clear, let the lines, A, B, fig. 2′, represent portions of parallel circles divided to half degrees; *n*, the point of the needle, and *c*, *d*, and *e*, *f*, visual rays; then by inspection of the figure, it becomes evident that the eye must, in passing from *c* to *e*, run over fifteen divisions on the outer circle before it can make the point *n*, appear to pass over one on the inner circle, so that the value of each division on the outer circle is two minutes, or of each degree four minutes. In reading off an instrument with this adjustment, we first observe the division which the needle has passed, (in the figure this is 21°) and then carry the eye on until we find some division which will fall in the same line with it and the needle point; in the figure this line is *c*, *d*, and the number of divisions passed over from 21° is 7, or 3° 30′, which makes the reading 21° 14′.

To find the magnetic declination.

Level the instrument by means of its screws, and ascertain the true meridian by the telescope, or sights, at the back, as the case may be, these being parallel to the plane of the needle, and note the angle indicated by the vernier on the horizontal limb. Turn the box round till the needle stands perfectly vertical, gentle friction* having been several times employed to cause the needle to take its true position.

The friction is produced by an ivory, or brass, surface being rubbed against the extremity of a pin which projects from the back of the extremity of the jewel plate, and again note the angle on the horizontal limb. The face of the instrument should then be turned round to the opposite quarter till the needle again becomes vertical, and if it required more, or less, than 180° to effect this, half the difference will indicate the true magnetic meridian, the face of the instrument being at right angles to it.

To ascertain the dip.

The face of the instrument having been made to coincide with the plane of the magnetic meridian, by turning it 90° from its last position, and vibration produced as before, the mean indications of both poles of the needle should be carefully observed and noted. The face should then be turned round 180°, so as to be again in the plane of the magnetic meridian, and the observations repeated and noted; the mean of the whole will indicate the dip.

To correct the observed dip.

The instrument being still in the plane of the magnetic meridian, screw on the deflectors, *k*, *k*, at right angles from the back, as shown in figure 3, so as to *repel* the ends of the needle which are nearest to them: adjust the deflectors at a given angle from the supposed or observed dip, say at 45° or at 50° from it, as shown by the vernier or verniers at the back.

Suppose after vibration, that the lower end of the needle settles at 115°

* This must in no case be omitted previous to reading off the place of the needle.

from the o on the north side of the instrument. Then turn the deflectors back to an equal angle from the observed dip, say 45° or 50° as the case may be, on the opposite side of it, which suppose to be 69° 20′, and that the poles of the needle stand at 23° 30′. Then 23° 30′ + 115°=138° 30′, which divided by 2, gives 69° 15′. Turn the instrument round 180° in azimuth and repeat the process, and if the result should be 69° 13′ the mean or corrected dip will be 69° 14′. Similar observations may be multiplied at pleasure by varying the angles of the deflectors from the observed dip, but generally three sets of observations will be perfectly satisfactory.

Mr. Fox generally employs one deflector to ascertain the true dip, as small angles seem often to give more uniform results than large ones. The following may be considered as fair specimens of the results obtained by this method, even with a four inch needle.* They were recently observed at Westbourne Green, Paddington, near London, by Mr. Fox, in company with Capt. Ross, R. N.

The deflector which repelled the north end of the needle having been screwed into the lower arm at the back, and adjusted at 40° from the apparent dip of 69° 20′ first on one side and then on the other.

First Observation.

Instrument facing East needle repelled to	87°	10′		
On altering the deflector to 40° on the other side, needle stood at	51	20		
Sum	138	30	which ÷2=69°	15′
Facing west needle repelled to	86°	58′		Mean
And afterwards to	51	42		69° 17′ .5
Sum	138	40	which ÷2=69°	20′

Second Observation

Deflector adjusted at 50° from apparent dip of 69° 20′ facing east	85°	20′		
And afterwards	53	8		
Sum	138	28	which ÷2=69°	14′
Facing west	85°	2′		Mean
And afterwards	53	36		69° 16′ .5
Sum	138	38	which ÷2=69°	19′
General Mean,				69° 17′

If the apparent dip had been taken at 69° 14′ or 69° 15′, the corrected dip would probably have been reduced to 69° 16′ or 1′ less, an original error of 5′ or 6′ in the apparent dip being reduced to 1′ by this method of correction. It may here be observed, that in this way the bearings of the

* Satisfactory as these observations are, a longer and heavier needle is found to give still more uniform and consistent results.

axle of the needle are changed, and by turning the jewel plate the resting places in the jewels are also changed, and under all these circumstances the results have been found most satisfactorily and remarkably uniform.

To ascertain the terrestrial magnetic intensity by means of weights.

Take off the deflector or deflectors and place the fine silk, with the hooks attached, on the grooved wheel, and suspend weights to one of the hooks so as to coerce the needle to a given distance, say 50°, from the actual dip at the station; and after applying friction as usual at the back, note the weights required; then change the weights to the other hook till the needle is coerced 50° on the opposite side. The weights required will indicate the magnetic intensity at the place of observation as compared with that ascertained in the same manner at any other place. Instead of having *given angles* to which the needle is to be deflected, it is more easy and practical to employ *given weights*, and the inverse ratio of the sines of the angles of deflection will give the intensity; corrections having been applied for differences of temperature at the different stations.

Mr. Fox has lately obtained many results of intensity, as well as of dip, at various places on the continent and in this country, with a small portable dipping needle deflector, having a 4-inch needle; and on this needle 1° of the Centigrade scale produces an effect on the angles of deflection equal to 2′ to 2′. 4. An example will show the method pursued.

Suppose two grains to be the given weight employed in one of his experiments, the instrument facing east, and that the needle counting from 0° was stationary at . . . 118° 8′ and afterwards on putting the 2 grains on the other hook at 20° 40′

Included angle	97	28; which ÷ 2 =	48° 44′
The same observations repeated facing west	.	=	48 38
Mean, instrument facing east and west			48 41
Temperature 17° centigrade, or taking 14° as the the standard, there would be 3° in excess, for which deduct			0 7
Corrected mean angle	.	.	48 34

the inverse ratio of the sine of which will show the intensity in relation to other results similarly made, and with the same weights.

Similar experiments may be made with other given weights, 2.1 grs., 2.2 grs., 2.3 grs., &c. for instance, and the number of observations multiplied at pleasure, and the mean of the whole taken.

The following are a few of the results which Mr. Fox has obtained, which may serve to show the working of the method in question. The needle used was only 4 inches long, and, consequently, did not give such uniform results as a larger needle would have done.

Mean results obtained at different stations near London.

Corrected angle, the instrument facing east and west.

Grs.		Intensity.
2.0	= 48° 36′ .7	= 1.0000
2.1	= 51 55 .3	= 1.0000
2.2	= 55 33 .0	= 1.0000

Eastbourne, in Sussex, Grounds of Davies Gilbert, Esq.
(Chalk.)

Grs.		Intensity.
2·0 =	48° 57′ =	0·9938
2·1 =	52 19 =	0·9921
2.2 =	55 57 =	0·9952
	Mean	0·9937

Eastwick Park, near Leatherhead, Grounds of David Barclay, Esq.
(Chalk.)

Grs.		Intensity.
2·0 =	48° 35′ =	0·9997
2.1 =	51 57 =	0·9996
2.2 =	55 40 =	0·9986
	Mean	0·9993

Grounds of Combe House, near Bristol, George Hilhouse, Esq.
(Limestone.)

Grs.		Intensity.
2·0 =	48° 25′ =	1·0023
2·1 =	51 45 =	1·0024
2·2 =	55 18 =	1·0031
	Mean	1·0026

Grounds of R. W. Fox, Esq., near Falmouth.
(Clay Slate.)

Grs.		Intensity.
2.0 =	48° 29′ =	1.0013
2.1 =	51 48 =	1.0017
2.2 =	55 20 =	1.0026
	Mean	1.0018

The intensity of the earth's magnetism may also be ascertained by means of the deflectors. For this purpose the latter should be screwed into the sockets in the arms at the back of the instrument, and adjusted to the dip at the station, so as to repel the needle from it, first on one side and then on the other.* Half the sum of the included angles will represent the force of the earth's magnetism in relation to that of the deflectors on a needle thus circumstanced; that is, at the angles which the latter makes with them respectively. The value of the sines of angles thus taken at different stations and with the instrument facing east and west, may be ascertained by means of small weights. For this purpose the deflectors should be placed *at the angle* of which the value is to be ascertained, the same to be calculated from *the actual dip at the place of observation where the weights are to be employed.* The weights required to coerce the needle back to the dip, against the force of the deflectors, will give that of the earth's magnetism on the needle, at the angle, the value of which is required, and in comparing the value of

* The position of the needle may be readily changed from one side of the dip to the other, by turning the jewel plate and its bracket by means of the knobs at the back.

different angles the sines of which will be greater or less in proportion as the terrestrial magnetic intensity is less or more, corrections must be applied according to the sines of such angles in an inverse ratio. Such observations, in order to be quite satisfactory, should be made with the deflectors adjusted on each side of the dip, and, when convenient, with the instrument facing the east and west, the mean of the whole being taken. Upon the whole, however, Mr. Fox prefers using the weights alone for ascertaining the intensity, if time should not admit of both methods being employed, which he finds they will do with a remarkable degree of uniformity and precision. It may here be observed, that if the needle should have sustained any diminution of force, it will settle at a *less* angle from the deflectors when in the dip at a given station, and at a *greater* angle when deflected by given weights only; whereas, if the force of the earth's magnetism should only be diminished by a change of station, the angles will be increased by both methods.

It is evident that if the deflectors are fixed at a constant angle from the dip, *at any given station*, and the needle is coerced, as before, into the line of dip, the weights required will be constant if no change has taken place in the magnetism of the deflectors, or the needle; and they will detect the amount of such change should it occur at any time or place.

In order to ascertain whether or not the needle itself has varied in intensity, remove the deflectors and screw the tube containing the second needle, which call number 2, into one of the arms at the back, so as for it to repel the suspended needle number 1. Adjust number 2 at any given angle, suppose 45° from the line of dip at the station, and coerce number 1 by weights into the dip. Repeat the operation with the opposite end of number 2, or rather screw the tube into the other socket. Half the sum of the weights required in both cases will indicate the repulsive forces of the needles with respect to each other under these circumstances at the angle of 45°. Remove number 2 from the back, and deflect number 1 to any given angle, say 45° from the dip, by means of weights only, and note the weight required to effect this. Change the needles, placing number 1 in the tube, and suspending number 2, and go through precisely the same operations as before. If, under these circumstances, there should appear to be any difference from the previous results in the reciprocal action of the needles, take the mean of both.

It is highly desirable that the deflections should always be made on *both sides* of the line of dip to ensure accuracy, and the process will be still more complete if done with the instrument facing both east and west.

In this manner the reciprocal force of the needles on each other may be ascertained, and their respective forces in relation to that of the earth's magnetism, under the circumstances described; and, therefore, approximately at least, the influence of any change in the former in relation to the latter, and vice versa.

These relations may be ascertained by experiments and varying the force of the needles at a given station where the terrestrial magnetic intensity is, for the time of their duration at least, presumed to be constant. And it can scarcely be doubted that this method furnishes the means of obtaining a true standard measure of the force of the earth's magnetism, at any time or place on given needles; or at least of approximating very closely to it.

In the course of such experiments it may, moreover, be found desirable to adjust the deflecting needle parallel to the arms at the back, (for which provision is made in the large instruments) and under such circumstances to repeat the operations which have already been described, with the deflect-

ing needle at right angles to the arms; and in both cases the given angles may be multiplied at pleasure; thus 40° and 50° may be taken as well as 45°, and the deflecting needle may be likewise fixed in the line of dip so as to repel the suspended needle from it, instead of using the weights alone for this purpose, and in this way the relation of the needles with respect to the earth's magnetism, may be ascertained by applying the weights as described in the case of deflectors.

It will not be requisite, at any time, to employ extremely minute weights; as the value of small difference in the angles may easily be estimated in weights; thus if $\frac{1}{10}$ of a grain should cause the needle, under given circumstances, to pass through 30' $\frac{1}{100}$ of a grain, will be represented by 3'.

In all observations on the magnetic intensity, the temperature should be noted, and the needful corrections applied, the amount of which may be readily ascertained by experiments, such as covering the instrument with a heated vessel inverted, or admitting heated air under it, &c. In one instrument, a needle, when deflected by weights 50° from the dip, had the angle increased more than one minute, by every degree (Fah.) of augmented temperature: in other needles of weaker intensity, the influence of temperature has been less considerable; the *ratio* appears to be nearly uniform within the ordinary range of changes in this climate.

If the needles are tempered very hard throughout, and, after having been magnetised, heated to 180° or 200°, Mr. Fox has found that they sometimes retain their force without any appreciable change for a long period of time, although he has continually observed that the magnetic axis* of a given needle, is liable to frequent variation, even without its having been retouched.

This is shown by its having at one time uniformly an excess of dip, when facing east for instance, and at another, when facing west, and this without affecting the mean results on either occasion. He also finds that needles attain their maximum force after having been rubbed by a magnet or magnets two or three times only. Annals Electricity.

NOTICES FROM THE FRENCH JOURNALS, TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE, BY J. GRISCOM.

Turbines.

M. Savary read a report (to the Academy of Sciences, Paris,) in his own name, and those of M. M. Prony, Arago and Gambey, on a memoir of M. Morin, containing the result of experiments on the turbines of M. Fourneyron.

Under the general name of turbines is understood water wheels which have scarcely any thing more in common than that of turning on a vertical axis. Those which an engineer, M. Bardin, invented and first made known under this appellation, receive the water at the top of a vertical cylinder or drum, and discharge it at the bottom. The water enters and issues near the circumference, and runs along spiral channels bent round the surface of the drum, which must be half as high as the whole disposable fall of the water.

* This fact suggests the expediency of having the wide part of a horizontal variation needle vertical and not horizontal, to ensure the greatest degree of uniformity in its indications.

In the turbines of M. Fourneyron, the drum is never very thick, a foot or so, for example. The water rushes obliquely in horizontal jets round the contour of an internal vertical cylinder, and enters all the compartments of the wheel, which, in its revolutions, just clears this cylinder, presses upon the curvilinear buckets which lie between the horizontal bases, and escapes horizontally by a vertical aperture in the exterior drum.

We may form an idea of the turbines of M. Fourneyron by supposing a common wheel with curved pallets to lie flat, and that the water, entering the pallets in the centre, issues at the circumference.

M. Poncelet proposed, in 1826, an arrangement the reverse of that now mentioned—the water entering at the circumference and passing off at the centre. It will be sufficient to state, that the experiments of M. Morin on the turbines of M. Fourneyron, lead to the conclusion that they are, at least, as advantageous as the best wheels of the ordinary kind;—in fact, under falls which varied from the weak value of 1 foot to those of 1, 2, 3, and 7 or 8 yards, the disposable work of the turbines amounted to 7 or 8 tenths of the motive power. This is the effect absolute. With regard to the variable circumstances under which a hydraulic mover may be placed for useful purposes, the reporter states that the turbines present some special advantages. They are, he says, in reality, of all kinds of hydraulic wheels, those which, under the least bulk, are available with the smallest quantity of water. The water which propels them does not press upon the axles. The immense velocities, and the variable velocities which they are allowed to take without sacrificing any thing of their effect, admits, in many factories, of the suppression of the wheel work and the heavy axles which are designed to transmit, with accelerated motion, the slow movement of the great bucket wheel.

Another property of the turbines is still more important. M. Morin, as well as other engineers, observes that they operate as well when immersed, (noyées) as when out of water. Perhaps it would be as well to admit, in such a case, of a slight difference.

At more than the depth of a yard under water, the liquid sheet escapes from the buckets with as much facility as at the surface. The action depends only on the difference of level between the upper and lower part of the current, and not upon the absolute height of either. This is a most valuable property of the new wheels, as it renders the entire fall of water available under all circumstances. L'Institut.

Saturn's Ring—A new Subdivision.

It is known that the ring of Saturn is composed of two concentric rings separated by an empty space, which presents the appearance of a dark line, visible only by powerful glasses. Short imagined that he had seen a greater number of subdivisions in the ring, and some modern observers have confirmed this assertion.

M. Encke made, last spring, some new observations on this celestial object with the great achromatic telescope of 9 inches aperture and 15 feet focal length, belonging to the Observatory of Berlin. The result he thus communicated to M. Schumaker.

On the night of April 25th, 1837, which was very clear, I tried, upon Saturn, a new achromatic ocular of the mechanician Duwe, of Berlin, with a power of 600, and a field of more than 6 minutes, in the whole extent of which the image had all the neatness that I could desire. Besides the com-

mon subdivision of the ring, I perceived, very distinctly, that the outside ring, which is the narrowest, was divided into two equal parts by a dark line. This line exhibits itself like the principal one seen in telescopes of less power. It may be followed from the extremities of the ansæ to their nearest proximity to the globe of the planet. It is equally distinct in the two ansa. The interior ansa of the interior ring, which always appears paler, presented an appearance which I had not before witnessed. A shadow, pretty wide at the inward edge, and narrowing off to a point at each ansa on the surface of the ring, had a rounded appearance, (l'apparence d'un arrondissement.) A certain number of fine lines were perceptible nearly parallel with the interior rounding, which penetrated the shadow in every part of the surface of the ring over which it extended. This appearance was particularly observable on the west side of the ring, seen to the left in the telescope.

On the 20th of May, the apparent division of the exterior ring was still visible, but the fine lines above alluded to were not discernible, for want, probably, of transparency in the air. I endeavoured, on the 28th of May, when the night was not as clear as that of the 25th of April and the 20th of May, to measure, by two trials, with the thread micrometer, the position of the lines of separation on the ring, as well as the exterior and interior diameters of the ring, and the equatorial and polar diameters of the planet. The values obtained and reduced to the mean distance of Saturn, were as follows:—

Exterior diameter of the exterior Ring . .	40″.445
Diameter of the new subdivision . .	37 .471
Interior diameter of the exterior ring . .	36 .038
Exterior diameter of the interior ring . .	34 .749
Interior do. do. do. . .	26 .756
Equatorial diameter of Saturn . . .	17 .519
Polar do. do. . . .	15 .927

These values appear to indicate that the line of separation is nearer the interior than the exterior border of the ring, but this conclusion is not to be regarded as devoid of uncertainty. The numbers obtained are sensibly greater than those of M. Bessel, and the results of my measures of this kind appear to me, in fact, to surpass, in general, those of M. Bessel, and even those of M. Struve. By the comparison of a great number of measures of this sort, the cause of this difference may be properly ascertained.

M. Encke then discusses observations of the same kind made by others, and among the rest, those of Captain Kater, which he did not recollect till after he had made his own. It appears that this phenomenon is variable, or that it requires a very special clearness of atmosphere, since Herschel and Struve could not distinguish, in the course of 1826, with their instruments, the new subdivision which Captain Kater and two other observers witnessed at the close of 1825, with less powerful apparatus. (Mem. Astron. Soc. Lond. v. 4.)

M. Encke reminds us that the face of Saturn's Ring, which was seen from the earth in 1825, is not the same as that which is now visible, so that the black line, as it is seen on each side of the ring, is, in all probability, a real division.

M. Arago appears to have observed it also at Paris, once in 1823, with a large achromatic telescope. Captain Kater and another observer thought they discovered, like Short, a greater number of black streaks or subdivisions of the outward ring, while a third person, who was observing with

them, could distinguish but one. M. Encke remarks on this, that the declination of Saturn was north in 1825, whereas it is now south, which, perhaps, may have prevented the other lines from being distinguished. M. Encke announces to M. Schumaker, in the same letter, that the two stars forming the double star γ of the Virgin, after having appeared for some time, on account of their reciprocal motions, so near each other as to appear like a single star, have been distinctly separable since the 29th of May of the present year. (Bib. Univ. Dec. 1817, or for further details, Astron. Nachr. No. 338.)

Ibid., Mars, 1838, Sup.

Electrical Phenomena.

M. Robert informed the Academy that on Wednesday, the 25th April, about 6, P. M., a few moments before the bursting out of a storm at Paris, he observed an enormous mass of cloud, towards which very numerous small clouds appeared to be attracted, and into which they were eventually precipitated.

Many persons say that this is not a rare occurrence. In some countries I have been told, where the clouds present those phenomena, they are called *diablotins*, (little devils.)

A fact somewhat curious was stated by M. Arago, that in Paris there are certain localities which appear to be much more likely to be struck by lightning than others. The Elysian Fields and the neighbourhood of the Place de la Concorde are in the number of these *privileged places.*

M. Becquerel, in his instructions to scientific voyagers, wishes them to observe the electrical intensity of the atmosphere. In clear weather, the air is a vast reservoir of positive electricity, the intensity of which increases from the surface of the earth to an unknown height. A few hours before and after the rising of the sun, this intensity shows two *maxima*, and a few hours before and after his setting, two *minima*, and these variations increase from July to January, so that the electricity of the air is much greater in winter than in summer.

In cloudy weather, the atmospheric electricity varies both in its nature and its intensity, and sometimes very rapidly. The intensity is much greater than in clear weather. No law has hitherto been established, only that in the course of a year, the number of positive days are about equal to the negative.

The atmosphere and the ground are always in opposite states, and these two electricities must be continually combining in the lower strata of air by means of the bodies on the earth's surface. In the open country, the positive electricity is found to commence at a little more than a yard above the surface in decidedly serene weather. It would be useful to study the variations of this height in different places and under different circumstances.

Near waterfalls, the atmospheric electricity is said to be negative, even under a serene sky. This fact deserves to be examined more fully.

When an electrical discharge passes through a body of sand in its nearest course to water, it produces vitrified tubes, called thunder pipes. These ought to be better examined.

Thermo-electric instruments ought to be applied to ascertain whether it is true that the internal heat in men and animals diminishes in going from the poles to the equator.

M. Peltier proved, several years ago, that in clear weather, the ground and the bodies upon it are negative, while the atmosphere above, beyond

local influence, is positive: when the clouds are negative in their lower strata, terrestrial bodies then change to positive, and this change of electrical condition is felt more or less according to the constitution of different persons, and the electrical intensity of the storm, producing complaints of heavinesss, headache, and a general listlessness, which people cannot account for. M. Peltier stated that in a storm on the 5th of May last, the inferior clouds were negative. Idem, Mai.

Progress of Civil Engineering.

"*On the Teeth of Wheels.*" *By* Robert Willis, *Jacksonian Professor of Natural Philosophy, in the University of Cambridge.*

The geometry of the subject of the teeth of wheels may be considered as complete, but it appears that important additions may be made to its practical applications. The general problem is, having given a tooth of any form, to determine one which shall work correctly with it. The method of effecting this may be shown in a simple, practical manner. The curve to be traced out, which is the shape of the required tooth, is the locus of the intersections of all the outlines of the tooth in every one of its positions. The motion produced by the mere contact of the curve so traced out with the given tooth, will be uniform. This, then, is a practical mode of showing the practicability of the problem.

The epicycloids and involutes have hitherto, from the facility with which they can be described, been almost universally employed, and practice has been confined to the class of epicycloids which work correctly with straight lines or circles. The defect under which such wheels labor is, that a wheel of fifty teeth of the same pitch will not work correctly with a wheel of one hundred teeth of the same pitch; since the diameter of the describing circle by which the epicycloid is formed, must be made equal to the radius of the pitch circle of the wheel with which the teeth are to work, and will therefore be twice as large in the second case as in the first. Also, if the teeth be epicycloids, generated by a circle whose radius is equal to that of the wheel with which it is to work, which is equally correct, the same remark applies.

This defect was of no great consequence when the teeth were wooden, but it is of great consequence in iron wheels, since the founder must have a new pattern of a wheel of forty teeth for every combination that it may be required to make of this wheel with others. It is desirable that the teeth of wheels be formed so that any tooth may work correctly with any other of the same pitch. This is the case with involute teeth, but the obliquity of the action is an objection to their introduction. The requisite property may be given to epicycloidal teeth, by employing the following proposition. If there be two pitch circles touching each other, an epicycloidal tooth formed by causing a given describing circle to roll on the exterior circumference of the first, will work correctly with an interior epicycloid formed by causing the same describing circle to roll on the interior circumference of the second.

From this, Professor Willis deduces the corollary, that if for a set of wheels of the same pitch a constant describing circle be taken and employed to trace those portions of the teeth which project beyond each pitch

line by rolling on the exterior circumference, and those which lie within it by rolling on its interior circumference, then any two wheels of the set will work correctly together. This corollary is new, and constitutes the basis of the system already alluded to.

It only remains to settle the diameter of this constant describing circle. The simplest considerations serve to show that the diameter of the constant describing circle must not be greater than the radius of the pitch circle; hence, as a convenient rule, make its diameter equal to the radius of the least pitch circle of the set. This rule is perfectly general, applying to racks and large wheels, as well as to annular or internal wheels. The simplicity of this above the old system is obvious, for on the old every epicycloid requires two circular templets; also there must be as many templets as pitch circles in the set, whereas on this system but one describing templet is required.

For machinery in which the wheels move constantly in the same direction, the strength of the teeth may be nearly doubled for the same quantity of material, by disposing it so that the backs are an involute or the arc of a circle, the acting faces being of the usual form.

In the preceding the exact forms have been described; the author then proceeds to ascertain forms sufficiently accurate for practice, and which are arcs of circles. Euler suggested the substitution of arcs of circles of curvature instead of the curves themselves. The portion of a curve employed in practice is so small, that a circular arc is sufficiently accurate, provided the centre and radius with which it is struck be determined by some more accurate method than by mere trial. With this view Professor Willis was led to investigate a method in which the nature and properties of curves proper for teeth are entirely neglected, and a simple construction is shown by which a pair of centres may be at once assigned for a given pair of wheels, whence arcs may be struck that will answer the purpose of enabling these wheels to work correctly together.

The nature of the motion produced by the pressure of one circular arc against another is then examined and reduced to that of a system of three rods, the middle one of which is joined to two others, movable at their other extremity about a fixed centre; and a simple construction is arrived at by which we may always find a pair of centres for which two circular arcs may be struck through any point, which will drive each other truly for a small distance on each side of that point. This point, when the side of a tooth consists only of a single arc, should be on the line of centres. It is, however, more advantageous that the tooth should consist of two arcs, for then there will be two points at which the action is exact—one a little before reaching the line of centres, the other a little after passing it.

From these investigations, the author was led to construct an instrument for setting out the teeth of wheels, which may be used with perfect facility by the workmen, and which has been termed an Odontograph, the application of which is fully described. The paper contains many practical observations connected with this subject, tables, &c., and concludes with some directions for ascertaining the correct form of cutters. Inst. Civ. Eng.—Lond. Journ.

"*The Canal Lifts on the Grand Western Canal.*" *By* JAMES GREEN, *M. Inst. C. E.*

The lift, which is the subject of the following paper, was erected by Mr. Green in the year 1835, on the Grand Western Canal, and has been in ope-

ration ever since. Lifts are not intended to supersede the use of locks in all cases, but in those in which a considerable ascent is to be overcome in a short distance, and in which the water is inadequate to the consumption of a common lock, or in which the funds are inadequate to the execution of the work on a scale adapted to such locks.

This lift is 46 feet in height, and consists of two chambers, similar to those of a common lock, with a pier of masonry between them; each chamber being of sufficient dimensions to admit of a wooden cradle, in which the boat to ascend or descend floats. The cradle being on a level with the pond of the canal, a water-tight gate at the end of the cradle and of the pond of the canal is raised up, and leaves the communication betwixt the water in the canal and in the cradle free, and the boat swims into or out of the cradle.

The cradles are balanced over three cast-iron wheels of 16 feet in diameter, to the centre of one of which is fitted spur and bevil gear, so that the motion may be given by machinery worked by the hand, without any preponderating weight of water in the cradle, when scarcity of water renders this necessary. To this hand-gear is also attached brake wheels and a brake lever for regulating the motion. For the details of the construction of this machinery, and of the manner in which the lifts are worked, reference must be had to the drawings.

It is obvious that the weights of the additional length of the suspending chains on the side of the cradle which is the lowest must be counterbalanced; for this purpose there is attached to the under side of each cradle a chain of equal weight per foot with the suspending chain, and this elongates under the ascending and is shortened under the descending cradle; thus the disparity in the weights due to the suspending chain is obviated.

It is so arranged that the water in the upper cradle is about two inches below the level of the water in the pond: the consequence of which is, that the upper cradle has a slight preponderance first, sufficient to set the machinery in motion; the weight of this water is generally about one ton; it may, however, be regulated at pleasure.

The strength of materials is the great desideratum in machinery of this nature, and though the lift here described is but 46 feet, and the boats about 8 tons, the same method is applicable to much greater heights and larger tonnage. The advantages of these lifts over common locks are great economy of construction, and great saving of time and water.

The time occupied in passing one boat up and another down this lift of 46 feet is three minutes, whereas thirty minutes would be required to attain the rise of 46 feet by locks; thus the saving in time amounts to $\frac{9}{10}$ths for boats of eight tons.

The quantity of water consumed is about two tons for eight tons of cargo, whereas in common locks it is about three tons of water per ton of cargo; the saving is therefore 22 parts out of 24, or very nearly 92 per cent. If the trade were all downward, there would, by the use of these lifts, be carried from the lowest to the highest level of the canal a quantity of water equal to the loads passed down.

Mr. Green stated, in reply to several questions, that in some parts of the canal it had been found impracticable to get a sufficient drain to empty the chamber—they were compelled, therefore, to use a half lock of 18 inches fall; that there were seven lifts and one inclined plane on the canal, effecting a rise of 262 feet in eleven miles. That he should not recommend them as applicable to boats of more than 20 to 30 tons. The width of

larger boats was an obstacle. They were extremely advantageous for narrow canals; for boats of 50 or 60 feet in length, and about 30 tons.

Mr. Parkes remarked, that he considered the question of narrow canals as a most important one—the advantage to be derived from narrow canals was a subject to which sufficient attention had not been paid.

The President called attention to the remark in Mr. Green's paper respecting the quantity of water carried up from one level to another in a downward trade wherever these lifts are used; then a coal country on high level may supply itself with as much water as it sends down coal. The subject of inclined planes being alluded to, especially those of the Morristown Canal of 200 feet each, where a rise of 1600 feet is effected by eight inclined planes, Mr. G. remarked, that more water and time must be expended, the friction and length being much greater. In the lifts there was only as much water consumed as was equal to the load, but that he should not consider them as practically applicable to more than 60 or 70 feet. Favorable levels, with ascents of more than 60 or 70 feet, could seldom be found; could he have had the choice of the line in this particular instance, he should have effected by four lifts the rise for which seven are now employed. Ibid.

"*The Land Surveyor's Calculator.*" *By* GEORGE HEALD.

The instrument to which the above name is assigned, was invented for the purpose of avoiding the necessity of performing long arithmetical calculations in surveying estates; the results are given at once by the adaptation and inspection of the instrument. It may also be applied to extracting the square roots of numbers, and to the other purposes to which the Gunter's scale is applicable.

The instrument consists of five concentric circles, whereof the four inner ones are on the outer edge of a card movable about a centre, and the fifth on the outer circle is fixed. The circumferences of the two outer circles—that is, of the fixed circle, and the circle at the edge of the movable card—are divided into 1000 logarithmic portions representing links, the divisions being carried round in a contrary order, on the two circles. The third circle is divided to represent acres; the fourth to represent perches; and the fifth, or innermost circle, expresses the area in acres, roods, and perches.

The author then describes the method of using the instrument for the solution of questions similar to the following. Knowing the diagonal and the two perpendiculars of a quadrilateral, or the base and perpendicular of a triangle, to determine the areas of the respective figures; the result is known at once in acres, roods, and perches, on inspecting the fourth or fifth circle, according as the area is greater or less than half an acre. The instrument may also be applied to computing square yards; to extracting square roots of numbers; and to the ordinary operations of multiplication and division, in the same manner as other logarithmic lines.

A great advantage of this instrument results from the graduation being on the circumference of a circle. Great enlargement of the divisions is thus obtained, and in a far more convenient form than by drawing a slide, as on the common sliding rule; the diameter of the outer circle in this instrument is sixteen inches. The author considers that a circle of eight inches diameter would be sufficiently accurate for practical purposes; and such an instrument would be extremely compact and portable. Ibid.

French Locomotives.

On the 25th October, the first locomotive ever built by French engineers with French iron, was tried on the St. Cloud and Paris Railway. It is, say the accounts, from 40 to 50 horse power; and able to draw 100,000 kilogrammes, or 20 laden wagons. The trial was perfectly satisfactory: it made the journey from Paris to St. Cloud in 16 minutes, and the journey back in 13½, which is at the rate of about 33 miles an hour. Its name is the *Alsace;* and it is curious to observe, that notwithstanding the boast of its being built by French engineers, it owes its origin to a province, politically French, indeed, but in language, manners, and character, still essentially German. It was built at the manufactory of Messrs. Stehelin and Huber, at Bitschwiller, in the department of the Upper Rhine, in Alsace—a manufactory large enough, it is said, to supply twelve locomotives a year—under the immediate superintendence of Mr. Stehelin, to whose talents it is indebted for a peculiar lightness and elegance of construction. The iron is more indubitably French, being supplied from the works of M. Muel-Doublas, at Abainville. The price of the locomotive is said to be no higher than that of an English one; as, though the cost of the iron is, of course, greater, the difference is made up by the less amount of wages paid to the workmen. Lond. Mech. Mag.

Bridge over the Danube.

The new suspension bridge over the Danube, between Buda and Pesth, which will be begun next spring, is a colossal undertaking. Two piers of granite and the red marble of Neudorf, 35 feet thick, and 150 feet above the level of the foundation, will support the whole structure. There will consequently be three openings for the water to pass through, the middle passage being 640 feet in width, and each of those at the sides 270 feet, making in all 1,180 feet. The entire length of the bridge will be 1,600 feet. Cast-iron beams will support the platform, which is to be 37 feet wide, viz. 25 feet for the carriage way, and six feet for each foot path. The whole will be suspended by 12 chains, weighing together upwards of 2000 tons.

Ibid.

The Suspension Bridge at Freyburg,

The longest in the world, was completed and thrown open in 1834. The engineer who constructed it is M. Chaley, of Lyons. Its dimensions, compared with those of the Menai bridge, are as follows:—

	Length.	Elevation.	Breadth.
Freyburg	905 ft.	174 ft.	28 ft.
Menai	580	130	25

It is supported on four cables of iron wire, each containing 1056 wires, the united strength of which is capable of sustaining three times the weight which the bridge will ever be likely to bear, or three times the weight of two rows of wagons extending entirely across it. The cables enter the ground on each side obliquely for a considerable distance, and are then carried down vertical shafts cut in the rock, and filled with masonry, through which they pass, being attached, at the extremity, to enormous blocks of stone. The materials of which it is composed are almost exclusively Swiss; the iron came from Berne, the limestone masonry from the quarries of the Jura,

the woodwork from the forest of Freyburg; the workmen were, with the exception of one man, natives, who had never seen such a bridge before. It was completed in three years, at an expense of about 600,000 fr. (25,000*l.* sterling.)—*Handbook for Switzerland.* Ibid.

Birmingham Railway.

There are only two coaches (formerly 22) now running to Birmingham from London, which will be put down in a few days, in consequence of the railway directors having purchased up the interests of the individuals to whom they belonged. In order to prevent the jobbing of the railroad monopolists, several public spirited individuals have determined to put three of Stafford's patent safety coaches on that road immediately, and we hope they may succeed, despite their tyrannical opponents. The Worcester mail has been again put on the road, in consequence of the uncertainty of railroad travelling.—*Worcester Herald.* Min. Journ.

Mechanics' Register.

East Indian Caoutchouc.

It is well known that a large supply of this valuable substance might be procured from India, if the same care were to be taken in gathering it as in South America. "The London Caoutchouc Company," impressed with this idea, accordingly sent to India an offer of a premium of fifty pounds for the first hundred weight of East India caoutchouc which should be shipped for England. When the offer arrived, however, it was somewhat of the latest; the great demand existing at home for the article had been heard of, and large quantities were already on shipboard, compared to which the "hundred weight" stipulated for was but as a molehill to a mountain! The whole affair forms an apt illustration of the doctrine, that, in commerce, the force of self interest is far superior to that of artificial bounties.

Mech. Mag.

Woolf's Engine Re-invented.

Mr. James Duncan, watchmaker, at Glenluce, has lately constructed a small steam engine on the high pressure principle, the novelty of which consists in the steam acting twice in the cylinder before it escapes into the atmosphere, by which there is a saving of half the fuel, and half the water, which a common engine of the same power would require.—*Ayr Observer.*

Mech. Mag.

Wheatstone's Electrical Telegraph.

On the bank by the side of the Great Western Railway, the directors are now laying down iron tubes containing wires, for communicating with the various stations by means of Wheatstone's electrical telegraph. The advantages, if it succeed, will be immense; the expense, we have heard, is about 100*l.* per mile. Ibid.

New Cordage.

The brothers Landauer, of Stuttgard, have obtained a patent for a new species of cordage; the threads of which are not twisted one over the other, but united in a parallel direction. A cord, 1¾ inch in circumference, sustained a weight of 1300 lbs. without breaking, and when at last an addi-

tional weight caused it to break, the fracture resembled a cut with scissors, which proves that each thread was of equal strength. A cord of 504 threads, $3\frac{1}{16}$ inches in circumference, 111 feet long, woven in this manner, only weighed 19 lbs.; whilst an ordinary cord of the same circumference and length, and as many threads, weighed 51½ lbs. Lond Mech. Magazine.

Artesian Well.

The bore which has been going on for so long a period near Paris, has now reached the depth of 410 metres (or about 1345 feet) and the funds being exhausted, M. Elie de Beaumont has been requested to examine the matters lately brought up by the auger, and to say whether they afford any indication by which the thickness of the bed to be pierced, before arriving at the sand, may be gathered. M. de Beaumont has accordingly given his opinion, that the bore has reached the lower beds of the chalk formation, and that the marls and gault which still intervene between the bore and the stratum where the water will be found, will, probably, be less than 100 metres thick, (328 feet.) If M. de Beaumont's anticipation should prove correct, the well should have a depth of 1600 feet, at which depth, according to recent calculations, the water should have a temperature sufficiently high to furnish Paris with an abundant supply of hot water for baths and for many other purposes. Mining Journ.

Machine Manufactory in Holland.

A company is at present forming in Holland for an undertaking of national importance, the establishment of a great manufactory of machines. Hitherto Holland has been almost entirely supplied with these from abroad, but the new company has been already joined by so many of the first manufacturers, as to hold out a strong prospect of success. At present, the most important establishment of the kind in Holland is the steam engine manufactory of the Steam Navigation Society at Feyenoord, near Rotterdam. Many hundred workmen are employed there, and a great number of steam engines are in course of manufacture, as well as a sea steamboat of 200 horse power. Lond. Mech. Magazine.

On the Use of Metal in Candles.

Much having been of late before the public respecting the making of candles, we venture shortly to bring the question before our readers.

To produce a candle that requires no snuffing, it is necessary that the whole of it, wick included, should burn away in flame; very fine wax and well refined spermaceti seem to be best suited for this purpose. To render other candles equally volatile, *arsenic* has been used with success; but the health of the community does not seem herein to have been regarded. Those candles which are used in the candle lamps, and sold under the name of metallic wick candles, have a small portion of the metal called bismuth introduced into them, which metal is perfectly harmless; it has the property of rendering the combustion of the candle more perfect, producing a white flame, and preventing the unpleasant smell that is observed on entering a room lighted with common tallow candles.

Bismuth, in the form of a white powder, is sold by perfumers as a cosmetic. Rep. Pat. Inv.

LUNAR OCCULTATIONS FOR PHILADELPHIA, APRIL, 1839.					Angles reckoned to the right or westward round the circle, asseen in an inverting telescope. ☞ For direct vision add 180° ☜	
Day.	H'r.	Min.	Star's name.	Mag.	from Moon's North point.	from Moon's Vertex.
2	13	30	Im. 1 b Scorpii	5	67°	48°
2	14	57	Em.		241	240
19	7	55	Im. 76 c Geminorum	6	102	157
19	8	56	Em.		212	271
20	10	33	Im. 43 γ Cancri	5	27	83
20	11	27	Em.		277	332

Meteorological Observations for October, 1838.

Moon.	Days	Therm. Sun rise.	Therm. P.M	Barometer. Sun rise.	Barometer. 2 P.M.	Wind. Direction	Wind. Force.	Water fallen in rain.	State of the weather, and Remarks.
				Inch's	Inch's			Inches.	
	1	55	71	29.95	30.00	N.W.	Calm.		Clear—do.
	2	57	70	91	29.94	N.W.	do.		Clear—do.
	3	60	70	80	80	W.S.W.	do.		Lightly cloudy—clear.
♉	4	48	59	30.00	30.00	W.S.W.	do.		Clear—do.
	5	51	71	29.95	29.9[illegible]	S.W.	do.		Clear—do.
	6	56	72	82	72	W.	do.		Lightly cloudy—do. do.
	7	53	59	72	85	N.	Brisk.	.04	Rain—clear.
	8	40	55	90	[illegible]3	N.E.	Moderate.		Clear—do.
	9	42	650	75	72	E.	do.		Clear—cloudy.
☽	10	54	59	65	52	N.E.	Brisk.	1.25	Cloudy—rain.
	11	46	43	40	54	S.W.W.	do.		Cloudy—do.
	12	43	50	75	71	S.W.	Moderate.		Partially cloudy—do. do.
	13	39	51	90	90	W.	do.		Clear—do.
	14	45	66	60	73	S.W.	do.		Cloudy—lightly cloudy.
	15	56	5	60	60	S.W.	do.		Cloudy—do.
	16	38	52	94	30.00	W.	do.		Clear—cloudy.
	17	37	54	30.25	76	W.	do.		Clear—do.
	18	36	53	34	30	S.W.	do.		Clear—cloudy.
⊗	19	49	59	05	29.84	E.S.E.	do.	1.60	Rain—do.
	20	43	50	29.83	85	W.	Brisk.		Clear—do.
	21	42	50	84	84	W.	do.		Cloudy—flying clouds.
	22	38	52	90	95	W.	Moderate.		Clear—flying clouds.
	23	34	52	30.15	15	W.	do.		Clear—cloudy.
	24	42	42	29.85	65	S.E.W	do.	.80	Rain—do.
	25	42	53	60	60	S.E.W.	do.		Cloudy—flying clouds.
☾	26	36	53	85	92	W.	do.		Clear—do.
	27	44	57	81	81	W.	Calm.		Flying clouds—do. do.
	28	42	42	85	85	N.W.	Moderate.	.15	Cloudy—rain.
	29	34	42	70	76	W.	Blustering.		Clear—do.
	30	33	45	90	90	W.	Moderate.		Clear—lightly cloudy.
	31	36	41	90	30.00	W.	Brisk.		Clear—Flying clouds.
	Mean	44.23	55.10	29.85	29.84			3.84	

	Thermometer.	Barometer.
Maximum height during the month.	72. on 6th.	30.76 on 17th.
Minimum " " "	33. 30th.	29.15 23
Mean	49.665	29.845

ERRATUM. The term Enpion, frequently used in Moll's Specification, page 100, of the present number, though copied literatim from the British Journal, should be *Eupion*, from the Greek *eu*, well, and *pion*, greasy. G.

METEOROLOGICAL REPORT

FOR THE STATE OF PENNSYLVANIA,

Collated from returns made to the Committee on Meteorology of the Franklin Institute of the State of Pennsylvania, for

FEBRUARY, 1839.

	County.	Town.	Observer.	Thermometer. 7, A. M.	2, P. M.	9, P. M.	Maximum.	Minimum.	Mean.	Days omitted.	Register. Lowest.	Mean.	Days omitted.	Barometer. 7, A. M.	2, P. M.	9, P. M.	
1	Philadelphia,	Philadelphia,	J. P. Espy.	30.28	39.53	33.07	52.50	17.	34.30	1/3				30.10	30.06	30.07	3
2	Montgomery,																
3	Bucks,	Newtown,	L. H. Parsons.	27.87	36.82	30.11	47.	8.	31.60	1/3				30.03	29.99	30.01	3
4	Lehigh,																
5	Northampton,																
6	Monroe,	Stroudsburgh,	Anna Maria Stokes.	24.86	37.43	28.18	53.	6.	30.16					29.58	29.60	29.60	2
7	Pike,																
8	Wayne,																
9	Susquehanna,	Silver Lake,	E. Rose.	21.61	30.96	27.00	48.00	—8.	26.52					28.10	28.10	28.09	2
10	Luzerne,																
11	Schuylkill,	Pottsville,	John Porter.	23.89	36.39	28.82	48.	2.	29.70	2/3				29.36	29.33	29.30	2
12	Berks,	Reading,	C. F. Egelman.	27.71	34.82	28.57	48.	6.	30.37					29.89	29.85	29.86	3
13	Chester,																
14	Delaware,	Haverford,	Haverford School.	27.48	42.07	31.00	50.	11.	33.52	2	10.50	25.37		29.62	29.57	29.45	2
15	Lancaster,	Lancaster,	Conservatory of Arts,	27.29	39.07	30.21	54.50	8.	32.19		8.	25.43		29.58	29.54	29.55	2
16	York,																
17	Lebanon,																
18	Dauphin,																
19	Northumberland	Northumberland,	Andrew C. Huston.	26.09	37.19	30.11	49.	3.	51.13		0.	20.34		29.51	29.44	29.49	2
20	Columbia,	Danville,	C. H. Frick.	28.06	45.56	32.89	53.	5.	35.57	11	2.	22.72	10	29.58	29.56	29.56	3
21	Bradford,																
22	Tioga,																
23	Lycoming,																
24	Union,																
25	Mifflin,	Lewistown,	J. Culbertson, M. D.	35.69	37.71	35.24	52.50	12.	36.21	2/3				29.42	29.39	29.39	3
26	Juniata,	Mifflintown,	Andrew Parker.	34.21	38.	37.32	52.	20.	36.51		18.	33.36		29.76	29.76	29.76	3
27	Perry,																
28	Cumberland,	Carlisle,	W. H. Allen.	26.89	37.71	30.21	53.	7.	31.60		5.	23.86		29.57	29.46	29.48	2
29	Adams,	Gettysburgh,	M. Jacobs.	27.33	38.44	31.08	53.75	7.	32.28		4.50	25.70		29.50	29.45	29.46	2
30	Franklin,	Chambersburgh,	A. Thompson, Jr.	28.29	44.65	31.80	57.	17.	34.91	1 1/3				29.46	29.46	29.41	3
31	Huntingdon,																
32	Centre,	Bellefonte,	John Harris.	22.05	38.07	27.43	57.	—3.	29.18		—5.	10.57		29.29	29.34	29.31	2
33	Potter,																
34	M'Kean,	Smithport,	Richard Chadwick.	20.89	34.89	25.14	50.	—6.	26.31		—10.	16.25	14	29.34	29.25	29.33	2
35	Clearfield,																
36	Cambria,																
37	Bedford,																
38	Somerset,																
39	Indiana,																
40	Jefferson,	Rose Cottage,	Charles C. Gaskill.	23.12	38.21	29.70	58.	1.	30.34					28.92	28.95	28.94	2
41	Warren,																
42	Venango,																
43	Armstrong,																
44	Westmoreland,																
45	Fayette,																
46	Green,																
47	Washington,																
48	Alleghany,																
49	Beaver,																
50	Butler,																
51	Mercer,																
52	Crawford,	Meadville,	Fred. Huidekoper.	22.50	36.39	26.53	54.	—2.	28.47		—8.	18.32		28.78	28.77	28.77	2
53	Erie,																

LUNAR OCCULTAT.			AP
Day.	H'r.	Min.	St
2	13	30	Im. 1 b
2	14	57	Em.
19	7	55	Im. 76
19	8	56	Em.
20	10	33	Im. 43
20	11	27	Em.

Meteorol

Moon.	Days	Therm. Sun rise.	Therm. P.M.	Bar. Sun rise.
				Inch
	1	55	71	29.
	2	57	70	
	3	60	70	
♈	4	48	59	30.
	5	51	71	29.
	6	56	72	
	7	53	59	
	8	40	55	
	9	42	650	
☽	10	54	59	
	11	46	43	
	12	43	50	
	13	39	51	
	14	45	66	
	15	56	5	
	16	38	52	
	17	37	54	30.
	18	36	53	
♉	19	49	59	
	20	43	50	29.
	21	42	50	
	22	38	52	
	23	34	52	30.
	24	42	42	29.
	25	42	53	
☾	26	36	53	
	27	44	57	
	28	42	42	
	29	34	42	
	30	33	45	
	31	36	41	
	Mean	44.23	55.10	29.

Maximum height during the
Minimum " "
Mean

ERRATUM. The term
ent number, though cop
Greek *eu*, well, and *pion*,

Thermometer.												
							Register.					
7, A. M.	2, P. M.	9, P. M.	Maximum.	Minimum.	Mean.	Days omitted.	Lowest.	Mean.	Days omitted.	7, A. M.	
.28	39.53	33.07	52.50	17.	34.30	6/30				30.10	30
.87	36.82	30.11	47.	8.	31.60	3 1/30				30.03	29
.86	37.43	28.18	53.	6.	30.16					29.58	29
.61	30.96	27.00	48.00	—8.	26.52					28.10	28
.89	36.39	28.82	48.	2.	29.70	3/30				29.36	29
.71	34.82	28.57	48.	6.	30.37					29.89	29
.48	42.07	31.00	50.	11.	33.52	2	10.50	25.37		29.62	29
.29	39.07	30.21	54.50	8.	32.19		8.	25.43		29.58	29
.09	37.19	30.11	49.	3.	51.13		0.	20.34		29.51	29
.06	45.56	32.89	53.	5.	35.57	11	2.	22.72	10	29.58	29
.69	37.71	35.24	52.50	12.	36.21	3/30				29.42	29
.21	38.	37.32	52.	20.	36.51		18.	33.36		29.76	29
.89	37.71	30.21	53.	7.	31.60		5.	23.86		29.57	29
.33	38.44	31.08	53.75	7.	32.28		4.50	25.70		29.50	29
.29	44.65	31.80	57.	17.	34.91	11 3/30				29.46	29
.05	38.07	27.43	57.	—3.	29.18		—5.	10.57		29.29	29
.89	34.89	25.14	50.	—6.	26.31		—10.	16.25	14	29.34	29
.12	38.21	29.70	58.	1.	30.34					28.92	28
.50	36.39	26.53	54.	—2.	28.47		—8.	18.32		28.78	28

Days omitted.	Barometer.							Weather.							Winds.															Hygrometer.				
	7, A. M.	2, P. M.	9, P. M.	Maximum.	Minimum.	Mean.	Days omitted.	Clear.	Cloudy.	Rain.	Snow.	Rain and Snow.	Thunder Showers.	Rain in inches.	Days omitted.	North.	N. N. E.	N. E.	E. N. E.	East.	E. S. E.	S. E.	S. S. E.	South.	S. S. W.	S. W.	W. S. W.	West.	W. N. W.	N. W.	N. N. W.	Calm.	Days omitted.	Dew-point.	Days omitted.	Wet Bulb.	Days omitted.	No. of Report.
	30.10	30.06	30.07	30.43	29.51	30.08	$\frac{1}{3}$	13$\frac{2}{3}$	14	3	3	1			$\frac{1}{3}$	2	1	2	1	2		$\frac{1}{3}$		1$\frac{1}{3}$	$\frac{1}{3}$	1$\frac{2}{3}$	$\frac{2}{3}$	$\frac{1}{3}$	1	3	$\frac{1}{3}$	7	4			36.60		677
	30.03	29.99	30.01	30.36	29.27	30.01	3$\frac{1}{3}$	7	13					3.400	8			5$\frac{1}{3}$				3$\frac{2}{3}$				4				12		3					669
	29.58	29.60	29.60	29.85	29.02	29.59		11	16$\frac{2}{3}$	2	4				$\frac{1}{3}$	2		2$\frac{1}{3}$		2$\frac{2}{3}$		1$\frac{1}{3}$		3$\frac{2}{3}$		7$\frac{1}{3}$		2$\frac{1}{3}$		5$\frac{1}{3}$		1		34.87	4	655
	28.10	28.10	28.09	28.80	27.52	28.10		11	17	2	3					1$\frac{1}{3}$							$\frac{2}{3}$	7$\frac{1}{3}$		3$\frac{1}{3}$	$\frac{1}{3}$	3$\frac{1}{3}$	$\frac{1}{3}$	10$\frac{2}{3}$	$\frac{2}{3}$					648
	29.36	29.33	29.30	29.90	28.75	29.34	1	8$\frac{2}{3}$	18$\frac{1}{3}$	1	3			2.639	1	$\frac{1}{3}$		$\frac{1}{3}$		1$\frac{1}{3}$		7$\frac{2}{3}$				3$\frac{1}{3}$		6$\frac{1}{3}$		6$\frac{1}{3}$		1$\frac{2}{3}$	$\frac{1}{3}$				642
	29.89	29.85	29.86	30.20	29.15	29.87		11$\frac{2}{3}$	16$\frac{1}{3}$									4		2		3$\frac{2}{3}$				3$\frac{2}{3}$	1$\frac{2}{3}$	1	1$\frac{1}{3}$	10.		$\frac{2}{3}$					643
	29.62	29.57	29.45	29.89	28.73	29.55	1$\frac{2}{3}$	12$\frac{1}{3}$	13					2.832	2$\frac{2}{3}$	2		3	1	3				1$\frac{2}{3}$	$\frac{1}{3}$	5$\frac{1}{3}$		3		5$\frac{2}{3}$		2	1	26.07	14			635
	29.58	29.54	29.55	29.92	28.71	29.56		12$\frac{2}{3}$	15$\frac{1}{3}$	4	3	1		3.885		1$\frac{1}{3}$	1$\frac{2}{3}$	4$\frac{2}{3}$		$\frac{1}{3}$		6	$\frac{1}{3}$	$\frac{1}{3}$		6$\frac{2}{3}$		$\frac{1}{3}$		5$\frac{1}{3}$	1			29.43		35.58		649
	29.51	29.44	29.49	29.84	28.70	29.48		7$\frac{2}{3}$	20$\frac{1}{3}$					1.991		3	$\frac{1}{3}$	1$\frac{2}{3}$		2$\frac{1}{3}$	$\frac{2}{3}$	1$\frac{2}{3}$		4$\frac{1}{3}$			$\frac{1}{3}$			1$\frac{1}{3}$	$\frac{2}{3}$	7					636
10	29.58	29.56	29.56	29.92	28.74	29.57	11	5	12					1.745	11			$\frac{1}{3}$				3	$\frac{1}{3}$	$\frac{2}{3}$	$\frac{1}{3}$			2		1$\frac{1}{3}$		9	11	23.37	12	37.22	12	708
	29.42	29.39	29.39	29.75	28.68	29.40	$\frac{2}{3}$	13$\frac{1}{3}$	14	3	3	1			$\frac{1}{3}$		$\frac{1}{3}$	3$\frac{1}{3}$	2			2				3$\frac{2}{3}$	3			8$\frac{1}{3}$			5$\frac{1}{3}$				697
	29.76	29.76	29.76	29.99	29.	29.74		10	18	4	3					1$\frac{2}{3}$		6$\frac{2}{3}$		3		2		1$\frac{1}{3}$		2		7$\frac{1}{3}$		4							644
	29.57	29.46	29.48	29.83	28.68	29.48		10$\frac{2}{3}$	17$\frac{1}{3}$	4	3	1		2.909		$\frac{2}{3}$	$\frac{2}{3}$	4	$\frac{2}{3}$	$\frac{2}{3}$		1	$\frac{2}{3}$	$\frac{2}{3}$	$\frac{1}{3}$	4$\frac{1}{3}$		2$\frac{2}{3}$	$\frac{2}{3}$	4$\frac{1}{3}$	$\frac{2}{3}$	6$\frac{1}{3}$		22.50	4	33.04	4	641
	29.50	29.45	29.46	29.81	28.67	29.47		14$\frac{2}{3}$	13$\frac{1}{3}$	3	4			1.726		4$\frac{1}{3}$	$\frac{1}{3}$	2$\frac{1}{3}$	$\frac{2}{3}$		$\frac{1}{3}$	1	$\frac{1}{3}$	2$\frac{1}{3}$	$\frac{1}{3}$	3$\frac{1}{3}$		4$\frac{1}{3}$	1	2	$\frac{2}{3}$	3$\frac{1}{3}$		25.60		34.35		716
	29.46	29.46	29.41	29.88	28.73	29.44	11$\frac{2}{3}$	6$\frac{1}{3}$	10$\frac{1}{3}$		2	1	1		11$\frac{1}{3}$			3$\frac{1}{3}$				1$\frac{2}{3}$				3$\frac{1}{3}$				1		1	17$\frac{2}{3}$				639
	29.29	29.34	29.31	29.67	28.57	29.31		6$\frac{2}{3}$	21$\frac{1}{3}$	1	4	1		1.773		2		4$\frac{2}{3}$		1		3		1		4		8$\frac{2}{3}$	$\frac{2}{3}$	2$\frac{2}{3}$	$\frac{1}{3}$						686
4	29.34	29.25	29.33	29.85	29.05	29.31		7	21	2	10			2.833		$\frac{1}{3}$				2		3$\frac{2}{3}$		$\frac{2}{3}$		3$\frac{2}{3}$		8$\frac{2}{3}$		5$\frac{1}{3}$		3$\frac{2}{3}$					657
	28.92	28.95	28.94	29.30	28.40	28.94	$\frac{2}{3}$	6	20$\frac{2}{3}$					2.665	1$\frac{1}{3}$	$\frac{2}{3}$		$\frac{1}{3}$	$\frac{1}{3}$			1$\frac{2}{3}$		$\frac{1}{3}$	$\frac{1}{3}$	5$\frac{1}{3}$		2$\frac{1}{3}$	$\frac{2}{3}$	1$\frac{1}{3}$		13$\frac{2}{3}$	1	29.80		35.48		661
	28.78	28.77	28.77	29.13	28.13	28.77		8$\frac{2}{3}$	19$\frac{1}{3}$		6	1		2.006		2$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	1$\frac{1}{3}$	7$\frac{1}{3}$	5	1	$\frac{1}{3}$	2		$\frac{2}{3}$	$\frac{2}{3}$	4				2$\frac{2}{3}$					721

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